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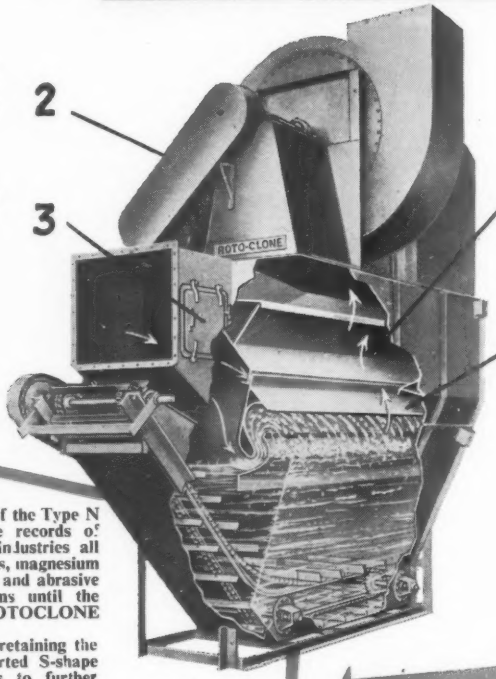

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FOUNDRY TRADE JOURNAL

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Olympian Highlights

The Engineering, Marine and Welding Exhibition and the Foundry Trades Exhibition was opened to the public last Thursday and was in a spick-and-span condition when the first visitors arrived. Every available inch of space at Olympia has been taken and the exhibits are as remarkable as they are varied. Hundreds of foundries, but mainly engineering concerns having facilities for making castings, display their finished products. There are, however, others solely devoted to exhibiting castings, and their finish—as they should be in such conditions—is of excellent quality. No-one could fail to admire the appearance of some of the gear wheels on the various stands.

An impression retained on leaving the foundry-equipment section is one of noise and cores. The former comes from the moulding machines, and whilst fundamentally, these have not changed a great deal in recent years, they certainly have made great progress in the handling of the finished moulds. There has been a resurgence in the use of snap-flasks—some new models are being shown and this system does cut down the provision for, and handling of, large quantities of moulding boxes. Cores are shown being made by the CO_2 Process, by shell moulding, and by core blowing on automatic machines, whilst many types of binders, both conventional and revolutionary, are being demonstrated by cinema, processing, or the finished product. Since the last exhibition, just four years ago, machines for liquid honing have come into use and have assumed importance. They are being used for the surface treatment of components of too-delicate a nature to withstand the rigours of shot-blasting. Perhaps no stands show more clearly recent developments in modern foundry practice than the exhibits of metal patterns. Their complication is only matched by their superlative finish. Whilst, nowadays, a patternshop is not an essential requirement for a foundry, a casting shop or special provision in a foundry is a prerequisite for a master patternmaker.

A mistake made by too many of the visitors to the Exhibition is to confine attention to the section which demands their major interest. This is a grave error, for founders are in the same position as engineers, and have need of a plethora of general supplies, tools and small machines. Such exhibits may not have the same appeal to founders as melting furnaces, sand-preparation machines, and so forth, but are nevertheless very important in keeping them abreast of the trend of development. Even a few minutes devoted to an examination of these items can handsomely repay the time spent and more than likely can make a serious contribution to paying one's travelling expenses.

G

Institute of Vitreous Enamellers

At the International Congress of the Institute of Vitreous Enamellers, October 9 to 21, at Leamington Spa, the following technical papers will be given:

Session I—"Enamelled Panels in Kitchen Units" by A. A. F. F. Buck, and "Porcelain Enamelling in Building Construction" by W. N. Harrison.

Session II—"Sheet-iron Vitreous Enamelling in Australia" by A. R. Williams; "Hydrogen Permeability and Connected Problems" by S. E. Dhalgren and Matton-Sjoberg; and "Fishscales. Observations of their Appearance on Enamelled Heavy Steel Pots and the Possible Causes" by E. Messmer.

Session III—"Practices of Coloured Sheet-iron Enamelling" by H. Ankerst; "Viscosity of Frits" by N. S. C. Millar and C. H. Buck, and "Coefficient of Thermal Expansion" by N. F. Parker.

Session IV—"Development of Opacity on White Porcelain Enamel" by Professor A. I. Andrews; "Enamelling Practices in Denmark" by H. C. Hertz and O. Schroder; and "Heat-resisting Enamels" by B. Zick.

Session V—"Standards of Quality" by J. M. Wijtenburg; "De-enamelling" by Mr. Camuset; and "Pickling" by D. Jackson, B.Sc., A.R.C.S., A. J. Stedman, M.A. and R. V. Riley, Ph.D., B.Sc., F.I.M.

Session VI—"Fusion Welding Processes for Vitreous Enamelling" by B. Trehearne, and "Development of Screen Printing Processes in the Ceramic Industries" by F. E. Kerridge.

General particulars of the social programme were published last week. Those intending to participate should make sure their "reply forms" are in the hands of the secretary (Mr. J. D. Gardom) of the Institute, at Ripley, Derbyshire, not later than September 10.

Dust Control and Ventilation Conference

The British Steel Castings Research Association announce that a conference on "Steelfoundry Dust Control and Ventilation" is to be held at the Royal Station Hotel, York, on October 13 and 14. The following programme has been arranged. At 2.30 p.m. on Thursday, the conference will be opened by the chairman of the Association, Mr. C. H. Kain. Then follows an address from HM Chief Inspector of Factories, Sir George Barnett. At 3 p.m., session I commences with "Dust Control in Steelfoundry Fettling Shops" Mr. R. F. Horton (chairman, BSCRA plant-engineering committee), presiding. "Dust Control on Pedestal and Swing-frame Grinding Machines," by Mr. C. M. Stoch (BSCRA), and "Dust Control on Portable Fettling Tools," by Mr. R. A. Duff (F. H. Lloyd & Company, Limited) and Mr. W. B. Lawrie (HM Inspector of Factories), complete the first session. The second session, presided over by Mr. D. W. L. Menzies (chairman, BSFA committee on Industrial Health), and starting at 9 a.m. on Friday, is to be devoted to "Foundry Ventilation and Space Heating," introduced by Mr. F. R. L. White (Brightside Heating & Engineering Company, Limited), and followed by general discussion.

Session III covers "Dust Sampling and Counting," with Mr. R. J. Richardson (chairman, BSFA sub-committee for practical work) as chairman; Mr. G. M. Michie (BSCRA) will initiate the discussion. The final session in the afternoon will be "Dust Control at Foundry Knock-outs," Mr. C. H. Kain in the chair and Mr. W. D. Bamford (of the British Cast Iron Research Association) introducing this topic.

Conference Paper Author

Mr. Holger Pettersson, Author of the official Exchange Paper from *Sveriges Mekanforbund*—"Spalling of Green-sand Moulds and its Relation to Casting Defects," printed on page 263 of this issue—studied metallurgy at the Royal Institute of Technology, Stockholm, graduating in 1943. After graduation he took up a temporary appointment as assistant at the Technical Institute and later in the same year was appointed to his present position of research engineer at the Swedish Institute for Metal Research. He spent two years doing research work on slag control.

Correspondence

MAGNESIUM FOUNDRY PRACTICE

To the Editor of the FOUNDRY TRADE JOURNAL

SIR,—The article "Magnesium Hazards and their Control" appearing in your August 4 issue, gives an extremely exaggerated idea of the special difficulties and dangers to be encountered in handling magnesium alloy which could, were it to get into the hands of ignorant or malicious persons, be the cause of a great deal of unnecessary trouble.

Most of the recommendations made such as "good housekeeping," "wearing goggles when fracturing ingots," are equally applicable to other metals, and it is not emphasized that the fire risk applies only to finely-divided magnesium, such as grinding dust and, to a lesser degree, swarf.

We had hardly expected to find the sentence "Metal which is moist . . . may generate so much steam or gas on immersion in the molten alloy that an explosion may ensue." We ought not to need to point out that in our own, or in any other foundry we have heard of, it is unnecessary for the management to discipline the worker prone to this type of behaviour. He is hardly likely to survive the treatment his workmates would provide. This applies whatever the metal being melted. We have a long experience of handling magnesium alloys and have never found the necessary and reasonable precautions to be more onerous to the management than in our other shops or foundries.—Yours, etc.,

E. F. MAILLARD.

Essex Aero, Limited.

Forty Years Ago

In the September 1915 issue of the JOURNAL there is an editorial note as to the making of steel castings weighing 30 tons by the *Fonderia Milanesi di Acciaio* using the baby Bessemer and other furnaces in conjunction with a mixer. There are two articles which show up very clearly the difference between American and British foundry practice. The former shows all the elements of mechanization in the making of tunnel sections, whilst the latter describes a pretty crude example of a then new moulding machine. Under "New Companies" appears the name of David King and Sons, Limited, a concern now forming part of Federated Foundries, Limited.

Spalling of Green-sand Moulds and its Relation to Casting Defects*

By H. Pettersson

The resistance of a plane mould against the sudden heat effect of the surface of molten metal below the inner mould surface has been studied by ordinary casting experiments or by observation through an open space between the upper and the lower mould-half, when molten steel or cast-iron has given off heat to the observed mould wall without coming into contact with it. The behaviour of the mould has been observed and the influence of the intensity of the heating on the spalling resistance of the mould. The composition of the moulding sand and mould hardness have been studied. Some other experiments of a supplementary nature have also been made.

Coarse-grain sands with wide grain-distribution, a high content of clay (preferably sodium bentonite) and an addition of coal-dust, cereals or sugar are the most important factors pertaining to the composition of the moulding sand that conferred good resistance of the moulds to spalling. At very low moisture contents, the resistance was also very good despite low mechanical strength of the moulds. Otherwise, the magnitude of the original moisture-content had very little influence. An effect of drying was not noted until the moisture content of the heat-affected part of the mould was decreased below about 0.4 per cent. Oven-dried moulds showed a much higher resistance than green-sand moulds. Certain additions, particularly those of an acid character, had a detrimental effect on the resistance of bentonite-bonded moulds. Except at extremely high- and low-hardness values, the resistance increased rapidly with decreased mould hardness. With bentonite-bonded moulds without extra additions, the time before the start of spalling decreased with increasing heating intensity only to a certain limit, whereupon the resistance increased again. Before the moulds failed by flaking, there was a more or less intense "rain" of sand from the heated mould surface. After that, pieces of uniform thickness usually scaled away from the exposed mould face. The thickness of these layers, as well as the difference in spalling resistance of moulds between "green" and dry sand are both believed to be connected with the low strength at the transition region between the dried surface layer and the wet sand behind. Exceptionally, the spalling could occur in a different manner. The spalling mechanism is discussed in respect of the temperature gradient that is formed in the mould; the surface layers of different character that are formed due to this gradient; the expansion curve of the sand; and the migration of moisture.

Among the various casting defects there is a group which is caused by the failure of surface layers in the mould as an effect of the heat from the molten metal. The most important casting defects in this group are rat-tails, buckles and scabs. These defects are very well known by every foundryman but not so much is known about the causes of their formation. In fact surprisingly few fundamental investigations have been made in this field. The problem is indeed very complicated and much more work will have to be done before the mechanism can be understood in detail. The present investigation, which is still proceeding, is an attempt to bring the knowledge of the subject at least one step forward.

Scope of the Investigation

The casting defects indicated can arise on cope or drag surfaces, but rarely on vertical surfaces. The defects on cope surfaces, where most of the heat that causes the defect is carried by radiation are those most suitable for a systematic investigation. Although a few experiments have been made in order to study the formation of scabs and similar defects on drag surfaces, almost all the work has been devoted to the spalling resistance of plain cope surfaces. In order to get a coherent chain of results the investigation was started with more or less normal casting experiments. Most of the experiments, however, have been made by observing the heat effect on a horizontal flat mould surface heated mainly by radiation from the surface of molten iron and steel in a mould cavity beneath this surface. The behaviour of the exposed part of the moulds and the effect of various factors on the spalling resistance of the observed mould part have been studied. Factors investigated are the materials in the mould, the degree of heat shock obtained by variation of the temperature of the metal and the ramming intensity. Some very valuable information

*Official Exchange Paper from the Swedish Foundrymen's Association (*Sveriges Mekanförbund*) to the fifty-second annual meeting of the Institute of British Foundrymen and International Foundry Congress, last June.

has also been obtained from temperature measurements at and near the mould surface exposed to the heat from the molten metal. On the other hand measurements of the thermal expansion of compacted moulding sand have not given any useful new points of view. The object of all these experiments was to obtain information which could lead to further investigations of important details. However the programme mentioned has been quite time-consuming owing partly to the great number of factors that can be varied and partly to experimental difficulties. Consequently very little in that line has as yet been done. It is also evident by now that further detailed investigations will meet with great difficulties. A certain development of the chief experimental method is, however, the use of thin surface layers of a composition different from the rest of the mould.

Experimental Methods.

(A) The first casting experiments were made in a mould as shown in Fig. 1a. The pouring rate was varied between 10 and 40 secs. by variation of the size of the sprue. Other factors which were varied were the type of sand and binder, moisture content and ramming intensity. Only simple synthetic mixtures of sand, bentonite and water were used.

(B) A development of method A was to arrange a 10 mm wide space between the upper and the lower mould part, so that the flat surface above the mould cavity could be observed during and after pouring (Fig. 1b). The time interval from the start of pouring to the first distinct sign of spalling was measured. Essentially the same kind of experiments as those made with method A were made with arrangement B.

(C) A limitation with methods A and B was that the longest possible pouring time was only 30 to 40 sec. (with steel). For that reason the test method was changed so that the moulds were furnished with an outflow and were poured directly from the melting furnace, a 300 lb. high-frequency furnace. At the same time the dimensions of the mould cavity were decreased so that constant conditions should be attained as fast as possible (Fig. 1c). During the constant stage, when equal quantities of metal were flowing into and out of the mould, the mould cavity was completely filled with molten metal. The free metal surface had a curvature which varied somewhat with the temperature and composition of the metal. The time required to reach the constant state was about 12 sec. During the experiments the time from the moment that the first metal flowed into the mould to the moment that something happened to the "ceiling" was measured. With this method it was possible to pour through one mould during about four minutes. Usually, however, four to six moulds with a test time between 10 and 60 sec. have been tested in sequence.

This method has been used for the major part of the investigation. Except the factors mentioned under A also the influence of the temperature and composition of the metal (steel or cast iron) were studied. The effect of various properties of the sand were studied in more detail than with the earlier methods.

(D) A small number of experiments have been made in an open mould of a special shape in order to study the formation of buckles and similar casting defects at the bottom surface of a casting.

In cases A to D the moulds were normally rammed in a jolt-squeeze moulding machine. When

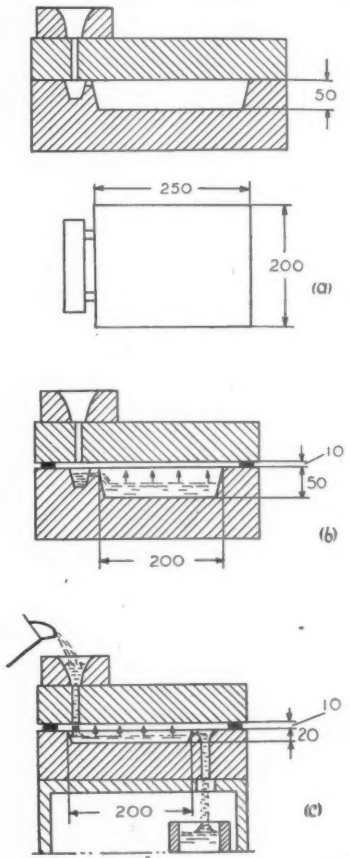

FIG. 1.—*Moulds used, (a) for test castings; (b) for the observation of a horizontal mould-face heated from beneath by slowly rising metal; and (c) (for the greater part of the investigation) for the study of the behaviour of a horizontal mould-face heated from beneath by a continuously regenerated surface of molten metal; (all dimensions in mm.)*

factors other than the composition—based on a rather pure silica sand with an average grain size of 0.3 mm (AFS—50), 5 per cent. of a sodium bentonite and 2.8 per cent. moisture was used.*

* The percentages given are usually based on the weight of the sand in the mixture. The moisture contents, however, are given as percentages of the total mixture (determined values).

During the experiments with methods A to C the following practice was followed. The temperature of the metal, which was mostly steel and sometimes cast iron or metal of intermediate composition, was measured in the furnace by means of immersion thermocouples. A temperature before pouring of 1,630 deg. C. was used as standard. Most experiments were made twice or more. Besides measuring the time interval between the start of pouring and the start of spalling the behaviour of the yielding mould wall was observed when possible and the thickness of the disturbed layers was measured.

(E) *Miscellaneous* : In a variation of method C thin layers of different sands were moulded at the exposed side of the mould. Some different combinations of sand were used with the interfaces at 1, 2, 3 or 5 mm from the mould surface.

In a number of green and dried moulds the rise of temperature at the surface and at the depth of 5 mm behind the surface of the tested mould wall was measured with thermocouples during pouring using the experimental method C. The thermocouples were bare and were placed so that the hot junction and the nearest 5 cm of the wires were in the same plane, parallel with the surface of the mould.

A few dilatation measurements were made on cylindric rods made from some representative moulding sands. The dilatometer used was of the vertical type. The mobile parts of the apparatus exceeded a pressure of 1.2 lb. per sq. in. on the test rods. The usual laboratory tests were made with all the different moulding sands used in the investigation.

Results

When the same type of experiment has been made by different experimental methods the results have always been compatible and there is thus no need to give separate accounts for the experiments made with each method. In some cases the results have not been conclusive. Some of these experiments and some others of minor interest have been excluded from this Paper as it is even then difficult to give an overall picture of the results. Some details are only mentioned in the discussion of the results.

I: Behaviour of the Yielding Mould Wall (Method B and C)

Mould walls of varying compositions not only spalled after different time intervals but also behaved differently under the influence of the heat from the molten metal. In almost every case the first sign of yielding was a more or less marked rain of sand grains which usually commenced from 8 to 10 sec. after the first metal entered the mould. If the mould wall had not spalled before that, the sand rain stopped again after about 5 sec. The intensity of the sand rain could vary very much. In a few cases it could not be observed with certainty and in others the space between the observed mould wall and the metal surface could be obscured by falling sand grains. Mould walls made of sands bonded with ball clay rained very heavily and so also did other mould walls when the moisture content was very low. When the binder was sodium bentonite, and particularly when the moulds were rammed very hard, the sand rain was not very prominent. Generally binders that give a strong and tough bond at moderately high temperatures (200 to 600 deg. C.) seem to decrease the intensity of the sand rain. The spalling, which usually took place 15 to 40 sec. after the pouring was started, could proceed in various ways. As a rule flat pieces were released from the surface rather abruptly. The pieces had a uniform thickness which on different occasions could amount to between 3 and 8 mm but usually was about 5 mm ($\frac{3}{16}$ in.). Generally the earlier the spalling took place the smaller and thinner were the pieces and the more abruptly did they fall. Only seldom, however, were the pieces smaller than 1-dm.^{2} (4-in. square). Usually the spalling was started by the falling of one piece. Immediately, or very soon afterwards, adjoining pieces would follow. If the mould resisted the thermal shock for more than 30 sec. the spalling layer usually scaled off more slowly and sometimes the first sign of spalling was a sagging of the surface layer which would hang down like a reversed vault before it broke. The release of layers from relatively resistant moulds usually started at or near the extreme border of the exposed surface where the layers failed by shear. If no spalling had occurred in 60 sec., a prolonged pouring time would usually have no effect. Already at about 30 or 40 sec. time interval before spalling occurred there was a tendency for the surface layer above the metal surface to give away as one piece. This indicates that the mould that was normally used was too small for those particularly resistant mould walls. However, only few of the tested green moulds have resisted this shock test more than 40 sec.

In some cases, when other clay binders than sodium bentonite were used, or when the sand was very fine grained and had a low moisture content, the spalling was of a different type. Instead of the normal pieces of uniform thickness and a size over 1-dm^2, very small pieces of irregular shape came down. They were squeezed away from the surface layer and dropped down, like snowflakes, at first tardily and then at a rapidly increasing frequency. With sand bonded with ball clay, a continuous transition from sand rain to spalling was the type of defect most often observed. After about eight sec. a sand rain started which then increased steadily in intensity during about five seconds. The separate sand grains were then successively substituted by sand aggregates and later also by pieces of the layer type.

(When the moulds resisted the heat exposure for 30 sec or more the surface of the moulds felt very hard and strong as long as it was hot. After cooling down to room temperature, however, they were quite loose.)

II: Expansion Characteristics of Rammed Moulding Sand (Method E)

As the expansion of the heated mould is intimately associated with its spalling it was considered worth while to determine the expansion curves for some different moulding sands rammed to small cylindrical rods. The curves all had the

same general shape as that for quartz. The most important difference was that green bentonite-bonded test-specimens expanded very little up to about 150 deg. C. Dry specimens and also ball-clay bonded specimens had a somewhat greater expansion up to 150 deg. C. though usually not more than 0.10 per cent. In Fig. 2 two typical expansion curves are shown. It was not possible to find any generally valid relation between the expansion curves and the spalling resistance of the corresponding moulds. This is not surprising as the expansion must be considered against the deformation that the mould can endure before it breaks, and as the temperature gradient is very steep in the moulds it is impossible to calculate the resulting effect from the different parts in the expanding layer.

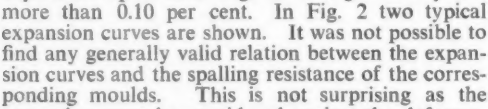

FIG. 2.—*Expansion curves for compacted moulding sand, bonded with (a) 5 per cent. bentonite and (b) 10 per cent. ball clay; moisture contents 2.8 and 4.5 per cent. respectively.*

III: Temperature Distribution in the Heated Mould Wall (Methods C and E)

An, at least approximate, knowledge of the temperature distribution in the mould during the heat attack is necessary for the understanding of the spalling mechanism. A number of temperature measurements were, therefore, made at the exposed surface and at a point five mm ($\frac{1}{5}$ in.) inside this surface under otherwise normal experimental conditions. From the obtained relation between temperature and time at the two points mentioned and by use of the laws of heat diffusion, the approximate temperature gradients prevailing at different times after the start of pouring could be outlined. Figs. 3a and b show the approximate temperature gradients at different time intervals for a green and a dried mould of the same sand composition. The graphs are based on the average of five separate measurements (a) and three separate measurements (b) respectively.

The curves for the two types of moulds are distinctly different in character. The movement of the 100 deg. C. isotherm (for the boiling-point of water) is much slower in the green mould than in the dried mould, especially after the first ten seconds. Further the surface temperature increases faster in the green mould than in the dried mould. Both these differences would normally be interpreted as the consequence of a smaller heat conductivity in the green mould than in the dried mould. In this case one cause of the difference seems to be that water is accumulated in the green mould in a narrow zone just behind the isothermal plane representing the boiling-point of water. This accumulation of water, which has also been observed by Gittus,[1] evidently decreases the temperature diffusivity of the mould. The reason for the higher surface temperature in the green mould is not obvious. As the heat conductivity should be the same in both cases in the zone heated above 100 deg. C. the difference in gradient should mean that more heat passes into the green mould. It is still difficult to understand how the higher surface temperature can be linked with the greater heat transmission. The explanation may be that the atmosphere of steam at and outside the green mould surface increases the heat transfer to the mould.

IV: Influence of Temperature and Composition of Poured Metal on the Tendency to Spalling (Method C)

A: Severity of the Heat Attack.

As most of the heat received by the observed mould wall is transferred from the upper surface of the metal flowing through the drag mould, the temperature of the metal and emissivity of the metal would be expected to have a great influence on the tendency of the mould wall to spalling. In order to obtain information as to these relations, experiments were

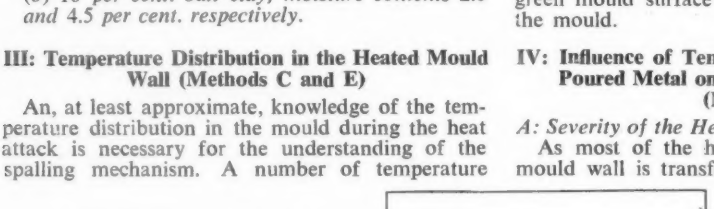

FIG. 3.—*Approximate temperature distribution in green (a) and dry (b) moulds at various time intervals after the start of pouring.*

made with the normal sand mixture and with pouring temperatures ranging from 1,270 to 1,660 deg. The temperature in the mould was of course much lower. The average loss of temperature was about 80 deg. C. The metals poured were cast iron, steel and iron of intermediate composition used respectively at low, high and intermediate temperatures. Besides at the normal pouring temperature, 1,630 deg. C., a great variety of steel compositions were tried. The temperature relations obtained are detailed in Fig. 4.

Evidently there is a direct relation between the intensity of the heat attack and the tendency to spalling only at the low and intermediate temperatures. At pouring temperatures above 1,550 deg. C. the relation is reversed.

Some experiments were made with a less refractory sand than the one normally used. In this case the resistance of the moulds began to increase with increasing temperature at a lower pouring temperature and the increase was much more pronounced than with the more refractory sand (Fig. 4 *a*).

B: Composition of the Poured Metal.

The variation of the carbon content from 0.08 to 1.22 per cent., the silicon content from 0.10 to 1.8 per cent. and the manganese content from 0.06 to 2 per cent. had a negligible effect on the spalling resistance of the moulds. Also great, but not determined, the variations in the content of hydrogen and aluminium had no noticeable effect on the spalling resistance. When the manganese content was increased to 3 and 4 per cent. an increase in the pouring time was required before the moulds failed. This effect may be attributed to the rather dense and dark smoke which was then developed above the metal and which must have decreased the heat transmission considerably.

It is somewhat surprising that the wide variations of the steel composition had so little effect on the spalling of the moulds as a great variation in heat emissivity should have accompanied these variations of the composition. The explanation may be that the experiments were made at a temperature (1,630 deg. C.) where even a considerable change in heat effect did not affect the time requisite for spalling. It is also possible that the carbon contents were too low to give a clear difference. At a somewhat lower temperature than 1,630 deg. C. also cast iron was used and then the moulds resisted the heat attack longer than when steel was poured at the same temperature (Fig. 4). However, the fact that even great variations in the metal composition did not affect the results at the normal temperature used in the experiments was useful as it made a rigorous metallurgical control unnecessary.

V: Influence of Sand Variables

A: Mineralogical Composition of the Sand. (*Method A, B and C*). Beside normal silica sands, sands of olivine, chamotte (sintered fire clay), sintered magnesite, sintered alumina, andalusite, and zircon were tried. With no other sand than silica did any spalling occur although the time of heat exposure was sometimes more than three minutes. It was thus not possible to determine the relative merits of the various sand materials. Under more severe test conditions, *e.g.*, with a larger exposed mould surface, such a classification would no doubt have been possible.

B: Size, Shape and Distribution of the Sand Grains (*Method C*). Silica sands of different origins, mixtures of different sands and separated grain size fractions were tested with five per cent. bentonite as the only binder. The moisture content was normally about 2.8 per cent.

(1) Several experiments were made with well graded sands and separated sand grain fractions of different average grain size. The results are summarized in Fig. 5, which shows the relation between the average grain size and the time elaps-

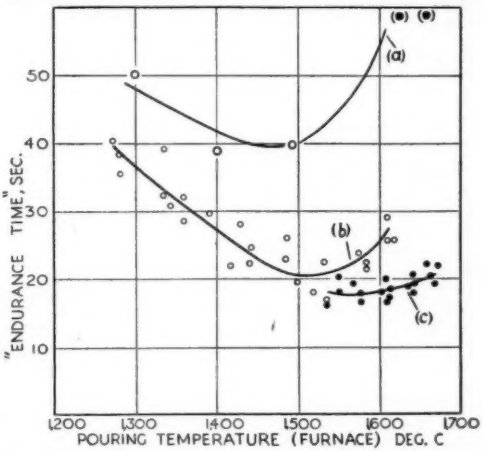

FIG. 4.—*Relation between time of resistance and temperature (taken while in the furnace) of the poured metal, for the sand normally used in the investigation. Curve (b) corresponds to cast iron, curve (c) to steel, and curve (a) shows the same relation for a more-easily-sintering sand. (The metal temperature in the mould is about 80 deg. C. lower than in the furnace.)*

ing from the start of pouring till the beginning of spalling. It appears that the spalling resistance increases approximately linearly with increasing grain size. When the average grain size was considerably less than 0.1. mm it sometimes happened that the mould resisted the heat exposure very well. This is indicated in Fig. 5 by a dotted line. The reason for this behaviour will be discussed later. When the sands were coarse and consisted practically only of grains of one size the moulds became very weak and it was difficult to avoid the falling of large sand masses before or during the pouring.

(2) The influence of the grain size distribution was studied by mixing several sands and sand fractions. The proportions were such that an average grain size of about 0.30 mm. was obtained. The spalling resistance of the moulds made from these mixtures was usually higher than the resistance of moulds made from well graded sands of the same average grain size. The best mixtures gave

Spalling of Green-sand Moulds

a time of resistance which exceeded that for standard moulds with about 50 per cent. A crushed quartzite with a very wide grain size distribution gave varying results, probably owing to inevitable differences in the grain size distributieon from one experiment to another. The results with this sand were always better, however, than those with the standard sands, which means that the unfavourable effect of the angular grain shape (paragraph (3) below) was, in this case, well compensated by the effect of a favourable grain size distribution. The experiments made do not allow general conclusions to be drawn as to which grain size distribution gives the best results. There is some evidence, however, that the best results are obtained with sands with a high packing density.

(3) There was a slight but marked difference between sands of different origin but of similar grain shape and grain size distribution. This difference can probably be ascribed to differences in surface properties, *e.g.*, the amount and size of small irregularities. A somewhat rough surface seems to give better results than a very smooth surface.

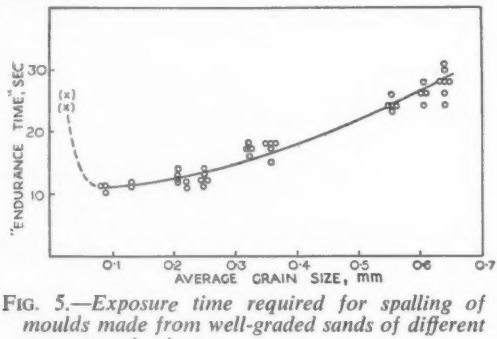

FIG. 5.—*Exposure time required for spalling of moulds made from well-graded sands of different average grain sizes.*

Separated grain size fractions of crushed quartzite—angular grains—were usually inferior to corresponding fractions of quartz sand with rounded grains. The fine-grained fractions gave similar results to normal sands, while the coarse-grained fractions gave worse results than normal sands of the same grain size.

C: Quality of the Clay Binder (Methods B and C).

A number of experiments were made with moulds bonded with 5 per cent. of some different bentonites and 10 per cent. of some other clays. The results expressed as the endurance time in seconds are given in Table I.

It is clear that the type and quality of the clay binder is of great importance and that sodium bentonites impart higher spalling resistance to the moulds than other types of clay binders.

D. Percentage of Clay Binder and Moisture (Methods A, B, C).

The influence of varying binder and moisture

TABLE I.—*Influence of the Type of Clay Binder on Spalling Resistance.*

Type and percentage of clay binder.	Endurance time, sec.	
Wyoming bentonite, 5 per cent.	25—30	(27.5)
Synthetic German bentonite, 5 per cent.	25—30	(27.5)
Sodium-treated African calcium bentonite, 5 per cent.	20—25	(22.5)
Sodium-treated Italian calcium bentonite, 5 per cent.	18—22	(20.0)
African calcium bentonite, 5 per cent.	14—16	(15.0)
Ball clay, 10 per cent.	12—15	(13.5)
African kaolinitic clay, 10 per cent.	10—13	(11.5)
Clay of unknown composition, 10 per cent.	9—11	(10.0)

contents in the moulds were studied simultaneously. Only one clay binder, a sodium bentonite, was used and the sand mixtures were made only from a standard sand, bentonite and water. The results given as the relation between the spalling resistance (endurance time) and moisture content for five different percentages of bentonite are shown in Fig. 6. As can be seen from the graph, the spalling resistance increases with increasing binder content. As the binder content increases, however, the results are more and more dispersed. The most striking effect of the variation of the moisture content is that the spalling resistance increases very rapidly when the percentage of moisture is brought down below a certain value, which decreases with decreasing percentage of bentonite. Unfortunately, this fact can hardly be made use of in practice as the moisture contents which impart this high spalling resistance are so low that the sand is too weak and friable for normal mould handling. The results are, however, of great theoretical interest. Another interesting point is that normal and high moisture contents give approximately the same results. In fact the highest moisture contents tried gave a somewhat greater resistance than normal contents, which was not expected.

Experiments made with moulds stored in ordinary indoor atmosphere, long enough to be dried out to equilibrium moisture contents, prove that the above-mentioned effect of low moisture contents is not primarily the effect of the percentage of water in the mould at the time of pouring. Moulds originally containing about 2.8 per cent. water were tested after storing when the moisture content had decreased to 0.4 to 0.5 per cent. In every case the spalling resistance of the stored moulds was practically the same as that of freshly made moulds with normal moisture content.

On the other hand, stoved moulds behaved quite differently. The spalling resistance of moulds dried at normal drying temperatures was always much higher than for green moulds of the same composition. In fact it was very seldom that a dried mould spalled at all during the time of exposure, which was in those cases about 3 min. Moulds, which had been stored for several weeks and subsequently oven-dried, behaved as normal dry moulds. Moulds which had been dried in the normal way and were stored so that they picked up 0.4 per cent. of moisture, however, behaved as normal green moulds.

In order to find an explanation of the remarkable spalling resistance of sands with an extremely low moisture content as mixed, some experiments

were also made with added ingredients, *e.g.*, hydrochloric acid, which inhibited the swelling of the bentonite. The result was a general decrease in spalling resistance but especially the great change in resistance at low moisture contents disappeared although a notable increase could be seen at still lower moisture contents than with the normal sand mixtures (Fig. 7 curve *c*).

With moulds bonded with 10 per cent. ball clay the relation between moisture content and spalling resistance was similar to that for moulds bonded with 5 per cent. bentonite + hydrochloric acid or sulphite lye. This is demonstrated in Fig. 7 (curves *a*, *b* and *c*). The HC1 and the water were added to the sand together as a diluted acid with 6 vol. per cent. concentrated HC1.

E. Effect of Added Organic Binders (Method C).

The addition of 1 per cent. of either cereal flour, dextrin or sugar to the normal sand mixture (5 per cent. bentonite, 2.8 per cent. moisture) in each

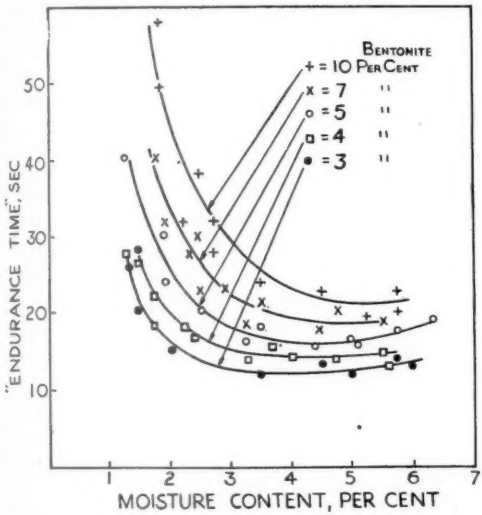

FIG. 6.—*Relation between spalling resistance (endurance time) and moisture content at* 3, 4, 5, 7 *and* 10 *per cent. bentonite.*

case increased the spalling resistance so much that no spalling occurred in the two or three minutes to which the exposure time was limited. No effort was made to find out the relative merits of these organic substances.

F. Effect of Various added Ingredients (Method C).

Several different additions were made to a mixture of a standard sand, 5 per cent. bentonite and usually 2.8 per cent. moisture. If much of a fine material was added the moisture was increased with 0.5 or 1 per cent. Of all the added ingredients in this group coal-dust was in a separate class (pitch and wood-flour were not tried). Moulds made from sand mixtures containing 5 or 6 per cent. coal-dust, 5 per cent. bentonite and 3.2 per cent. moisture were so resistant that the severity of the test was often not sufficient to cause a failure. It was evident, however, that the quality of the coal-dust is of great importance. A poor coal-dust with a small gas content, that was tried, had very little effect. In combination with an easily sintering sand which had given unexpectedly good results, this coal-dust even reduced the resistance considerably.

Some additions had no notable or very small influence on the spalling properties of the moulds. Among these the following can be mentioned: 2 per cent. chalk powder, 1 per cent. iron oxide, 5 per cent. dead-burnt bentonite, 6 per cent. lampblack, up to 10 per cent. silica flour. The iron oxide decreased the spalling resistance a little or had no effect; the chalk and the dead-burned bentonite increased it slightly while silica flour sometimes increased and sometimes decreased the resistance. It should be kept in mind, however, that if green-strength or dry-strength is used as standard of comparison instead of the binder content the results will be quite different, as the additions have a strong influence on these properties.

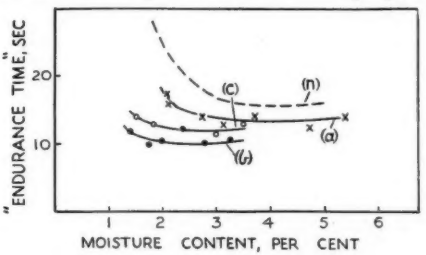

FIG. 7.—*Variation of spalling resistance with moisture content of sand in moulds bonded with (a) 10 per cent. ball-clay; (b) 5 per cent. bentonite + 1 per cent. sulphite lye; and (c) 5 per cent. bentonite + HC1 in a concentration of 6 vol. per cent. of the water content. For comparison a curve (n) for a mould bonded with 5 per cent. bentonite and no extra additions is also given.*

Some substances, which inhibit the swelling of bentonite in water, decreased the spalling resistance of the bentonite bonded moulds. All acids seem to have this effect. Sulphite lye at some concentrations inhibits the swelling of bentonite but it also seems to have other properties which have a negative influence on the spalling resistance. Two qualities of sulphite lye were tested, one of which gave very poor results (Fig. 7b curve) and the other had a less impairing influence on the spalling resistance. Both had acidic reactions in water solution. When so much soda was added, that the reaction became weakly alkaline the result became the same as if no additions had been made to the normal sand.

G. Experiments with Layers of Different Sands (Method C)

The following three sand mixtures were used in severals combinations:—

(a) Standard sand + 5 per cent bentonite + 2.8

per cent. moisture; (b) Standard sand + 10 per cent. ball clay + 3.5 per cent. moisture; and (c) Standard sand + 5 per cent. bentonite + 1 per cent. dextrin + 2.8 per cent. moisture.

The results can be summarized as follows:—

The spalling resistance of a mould with a 1.5-mm thick surface layer differed little from that for the sand in the rest of the mould. Only when the dextrin sand was used on a clay-bonded sand the spalling resistance was considerably increased.

If a 3- or 5-mm thick surface layer of sand "b" was put on sand "a" and also if a 3-mm thick layer of sand "b" was placed as a second layer with sand "a" as a 1.5 mm thick surface layer and backing sand the spalling resistance was practically the same as if the whole mould had been made of sand "b."

If sand "a" was used as a 5-mm thick surface layer on sand "b" the resistance of the mould was the same as if it was completely of sand "a." With a 5-mm thick surface layer on sand "c" the resistance was much higher than for sand "a" but less than for sand "c."

Thus sand "c" had a positive influence in each of the positions tried and sand "b" had a negative influence except as a 1.5-mm thick ulimate surface layer.

H. Effect of Varying Ramming Density (Methods A and C).

The well-known fact that loose ramming decreases the tendency to scab formation was verified by the experiments. The moulds were rammed manually as the desired variations could not be obtained with the moulding machine otherwise used. By measuring the mould hardness with a G.F. (G. Fischer) mould hardness tester a quantitative relation between mould hardness and spalling resistance was obtained for the normal sand mixture.

Fig. 8 shows that the spalling resistance increased rapidly with decreasing hardness only in the range of normal hardness values. At very high ramming intensities somewhat better results were obtained than when the ramming was a little less hard. Below a certain critical hardness value the increase in resistance ceased. The moulds then did not spall in the normal manner. Instead, a large part of the moulds fell down because of the weakness of the mould.

It must be emphasized that mould hardness is not in itself a good measure of spalling resistance. Thus with the same (normal) ramming intensity but increased binder content both the mould hardness and the spalling resistance increase.

I. Treatment of the Sand.

The effect of the mixing efficiency was examined by comparing the results with three different sand mixers and by varying the time of mixing. The experiments showed that the results were much better when the mixing is made in a roller mixer than in a propeller mixer and that bad spalling resistance is likely to be obtained if the mixing time is short (for the mixer in question).

In modern mechanized foundries it may occur that the used sand returning to the sand mixer is hot. This may result in a bad sand mixture and a drying out of the sand during and after mixing. An experiment with a sand that had a temperature of 50 deg. C. when it was mixed with bentonite and water, did not show any effect on the spalling resistance of the high sand temperature. Although this is a positive result it can not, of course, be considered as a proof that hot sand cannot be the cause of scabs and similar defects.

VI: Influence of the Size of Mould Surface

Beside the experiments with the standard mould with an exposed surface of 200 by 200 mm (8 in. by 8 in.) some experiments were also made with a fairly large exposed mould surface, 300 by 400 mm (12 in. by 16 in.), with a mould with an exposed surface 250 by 200 mm and with the standard mould (9 in. by 8 in.), divided in smaller squares separated by scores about 2·5 mm wide and 5 mm deep. The results with the moulds without notches indicated that there was usually a steady increase in the exposure time endured before spalling occurred, but

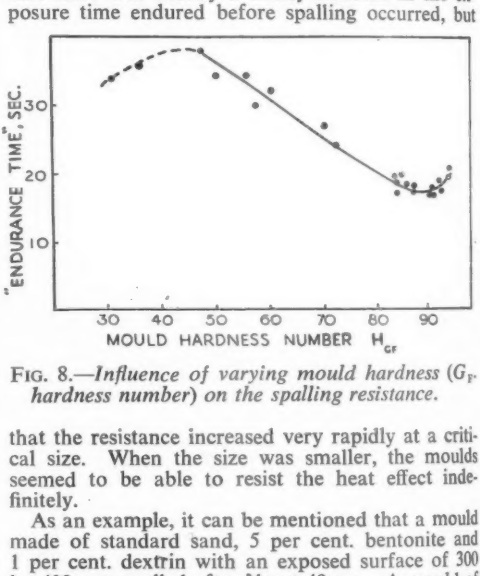

FIG. 8.—*Influence of varying mould hardness* (G_F *hardness number*) *on the spalling resistance.*

that the resistance increased very rapidly at a critical size. When the size was smaller, the moulds seemed to be able to resist the heat effect indefinitely.

As an example, it can be mentioned that a mould made of standard sand, 5 per cent. bentonite and 1 per cent. dextrin with an exposed surface of 300 by 400 mm spalled after about 40 sec. A mould of the normal size (exposed surface 200 by 200 mm) of the same sand did not spall in two minutes.

The results with the notched surface was somewhat surprising as they were sometimes better sometimes worse than with no notches. The results seemed to depend on the shape of the notches.

VII: Casting Defects on the Cope Side of Experimental Castings (Method A)

A great variety of casting defects was obtained on the upper side of the experimental castings that were made in the early stages of the investigation. Buckles, rat tails and similar defects were most frequent. Generally it could be seen that the furrow

from which the " root " of the buckles, *i.e.*, the thin connection between the buckles and the protruded pieces (fins) continued and appeared as furrows or rat tails on two sides of the buckle, sometimes with a low metal fin protruding from the deepest part of the furrow. The size and shape of the buckles could vary very much and it was noticed that the pouring temperature (the fluidity) of the metal had a great influence on their appearance. Also buckles obtained with cast iron differed much from those obtained with steel, due to the much greater ability of cast iron to penetrate into and fill small apertures. Most of the other defects would best be characterized as sand inclusions caused by the falling of pieces of a surface layer of the mould. The formation of all the defects could easily be understood as being the result of the spalling (in an early or later stage) of the mould and the more or less complete filling of available space and sometimes also moving of the more or less released sand layers by the rising metal.

VIII: Casting Defects on the Drag Side of Experimental Castings, and Observations relating to Mould Failures in the Drag Part of the Mould (Method A and E)

The bottom surfaces of the experimental castings showed several kinds of furrows (rat-tails, etc.) but very seldom buckles or scabs. One reason for the almost complete absence of the latter defects may be that almost all these experiments were made with steel and the fairly small castings solidified rather rapidly. There was generally a definite relation between the position and direction of the furrows and the paths of the metal streams that entered the mould through two parallel ingates. It seemed as though those surface layers which were heated chiefly by direct contact with the flowing metal expanded in all directions away from the metal streams as an effect of the sudden expansion stresses developed under the metal. At some small distance from the metal the strain became too great and the mould layer failed by shear. Afterwards the cracks were covered with metal, whereby the casting defects outlined were obtained.

The observations made when cast iron was poured in an open mould, made for the study of drag side defects, gave the same impression of the yielding of the mould. Moreover it was noted that the mould spalled easily where a vertical part of the mould against which the metal flowed formed an edge with a horizontal surface. Because of this edge comparatively little resistance was offered against the expansion movement of the surface layer.

REFERENCE

[1] J. H. Gittus, " Influence of Mould Factors on Casting Defects," B.C.I.R.A., *J.* of Research and Development, **5**: 5, 1954, 264-277.

(*To be continued*)

Improving Utilization of Metals

Cutting costs of production is an essential item in improving or even retaining industry's competitive power and a saving at any stage in a manufacturing process has become of paramount importance. According to a sub-committee of the Institution of Production Engineers, the metal-working industries might profitably examine the effectiveness of their utilization of materials. In a report on the subject the sub-committee states that for a wide range of machined parts the proportion of material converted into saleable goods is seldom greater than 70 per cent. and frequently less than 30 per cent.

Considering a not unusual material utilization figure of 33 per cent., the report says that of the original material, two thirds are machined away and disposed of as swarf at approximately 10 per cent. of its original cost. An increase in material economy in this case to 70 per cent., by no means impossible, would be approximately equivalent to halving the material cost for a part. This is only part of the reduction, however. The machining away of the original material involves labour costs, both at the machine and in the disposal of the swarf, and absorbs machine capacity and shop floor and handling space.

The sub-committee concludes that it may well pay handsome dividends to spend considerably more money in purchasing a form of semi-finished material, which is intrinsically more expensive, but closer to the shape and size of the finished part, in order to achieve drastic reductions in further processing.

THE SECOND annual Park Foundry horticultural show was held in the works canteen, Derby Road, Belper. The show was opened by Mr. W. A. Ballard (managing director) and the awards were presented by Mrs. Ballard.

World's Largest Blast Furnace?

Blast-furnace hearth-diameters are steadily increasing. Great Lakes Steel Corporation, Detroit, Mich., division of National Steel Corporation, in June, blew-in " A " furnace which has a hearth diameter of 30 ft. 3 in. It was designed and erected by the Freyn department of Koppers Company Inc., Pittsburgh, and is expected ultimately to produce an average of over 60,000 net tons (2,000 lb.) per month. From ground level, the furnace has a height of 252 ft., resting on a concrete pad 71 ft. dia. and 16 ft. thick, supported by steel piling extending 84 ft. down to bed rock. Its total weight when fully charged is over 12,800 tons, states " Blast Furnace and Steel Plant " for July, which claims it is the largest in the world. Some of the other more important details are as follow: Bosh, 33 ft. 3 in. dia.; bosh height, 11 ft. 3 in.; stock line, 23 ft. dia.; bell, 16 ft. 6 in. dia. The iron notch is 2 ft. above the hearth bottom, the cinder notch being 4 ft. 11 in. higher; cinder notch to tuyeres 3 ft. 9 in.; above a straight section of 8 ft. in height the sloping inwall rises 60 ft., the bend line to the hopper ring being 20 ft. 8½ in. These and other minor dimensions give a total height of 110 ft. from the iron notch to the hopper ring. Bosh angle, 82 deg. 24 min.-20 sec.; inwall batter, 1.024 in. per ft.; tuyeres, 24; columns, 8. Furnace volumes are as follow: Iron notch to bell, 64,425 cub. ft.; tuyeres to 7 ft. below bell, 55,300 cub. ft.; relative volume, 130.4.

A FURTHER STAGE in the 10-year programme for the expansion of its turbine business will be reached by the British Thomson-Houston Company, Limited, on September 29 when the Prime Minister of Northern Ireland, Viscount Brookeborough, lays the foundation stone of the office block of the new turbine works at Larne (Co. Antrim).

Aluminium for Patternplates*

The general consensus of opinion is that aluminium alloy, LM4, gives the best all-round results as regards machinability and service. It is, moreover, slightly cheaper than the usual alternative alloy, LM6, and provides a better skin finish. It is free from distortion, but for the very best results LM4 castings should be given a heat-treatment to relieve any stresses present, and so give the best dimensional stability—obviously an important item for certain patterns. The heat-treatment may be varied, but typical cycles would be 4 hours at 250 deg. C. followed by cooling in still air, or 8 hours at 165 deg. C.

For large patterns, alloy LM6 is often chosen because, being less brittle, it is less liable to breakage. It also has better resistance to unavoidable impacts which may occur when hand ramming is undertaken. The corrosion resistance of LM6 is better than LM4, but the amount of corrosion experienced is not usually significant, and is not a major factor in the choice of alloy. It is only when patterns are stored for long periods that any appreciable corrosion occurs, and in such cases LM6 has some advantage.

Alloy LM3 is not normally used for patternplates to-day. As it contains a high percentage of zinc, its corrosion resisting properties are appreciably lower than the other two alloys, but it is certainly easier to file than LM4. Furthermore, its dimensional stability would not be as good as LM4 or LM6, and the alloy would be more liable to breakage in service.

Finally, as regards corrosion, it should be added that many patternplates have been in use for more than a dozen years without suffering from any corrosion troubles, but, where they occur due to poor storage conditions, they can be largely overcome by applying a coat of pattern varnish, after the pattern has had a very light shotblasting to provide the necessary key.

* These notes were prepared by Dr. E. G. West, of the Aluminium Development Association, for the National Society of Master Patternmakers, and were circulated to members in their *Bulletin* No. 4.

Iron-ore Imports

Iron-ore imports in July, and the total for the first seven months of this year compared with the corresponding period of 1954, are shown below.

From	Month ended July 31.	Seven months ended July 31.	
	1955.	1954.	1955.
	Tons.	Tons.	Tons.
Sierra Leone	59,250	327,641	394,375
Canada	101,323	493,557	436,170
Other Commonwealth countries and Eire	1,994	29,885	8,097
Sweden	352,033	2,445,120	2,016,398
France	54,512	283,454	385,122
Spain	49,910	299,239	466,724
Algeria	196,632	1,317,887	1,355,590
Tunisia	81,455	371,240	440,115
French Morocco	25,280	166,276	164,695
French West Africa	58,867	401,694	343,607
Spanish Morocco	9,150	166,871	124,255
Liberia	20,110	135,967	153,080
Brazil	77,847	248,760	287,732
Other foreign countries	39,282	225,787	209,122
TOTAL	1,127,645	6,913,378	6,785,032

Commercial Production of Zirconium

Zirconium, one of the most important metals used in atomic reactors, is now being produced in the United States on a commercial scale. The USA is the only country which is able to achieve this. The metal is used in atomic plants for certain nuclear fuel elements, because it has the rare property of resisting the bombardment of neutrons. At a Press conference at Geneva, Dr. Charles Eichner, the French atomic energy commission's chief metallurgist, stated that the United States produced 5,000 tons zirconium last year and that this year it was expected that 30,000 tons would be produced. Dr. Eichner pointed out that Britain and France were also producing the metal; they could not market it commercially, however.

On the same day, at the international conference on the peaceful uses of atomic energy at Geneva, Dr. S. M. Shelton, Dr. E. D. Dilling, and Dr. J. H. McClain, of the US Bureau of Mines, stressed the importance of zirconium as a metal for atomic power. They said it was the leading cladding and structural material for many kinds of reactors because it had mechanical strength and stability when exposed to high temperatures, high pressure, corrosive fluids, and metals. Zirconium could also be relied on to provide leak-tight casing, while not absorbing the neutron particles required to keep the nuclear reactor furnace of an atomic power plant burning.

Dr. Shelton told the conference that zirconium was also resistant to mechanical damage by radiation and formed few highly radioactive products as a result of exposure to heavy radioactive bombardment. It was possible, too, to repair structures made from zirconium by remote control methods. Zirconium played an important part in the manufacture of atomic power plants of the submarines Nautilus and Seawolf. Dr. Shelton also told the Geneva conference that the US Bureau of Mines' producing plant now had a capacity of some 300,000 lb. of zirconium a year.

UK Factory Building Since the War

The end of the war in 1945 brought the United Kingdom to the threshold of its task of rebuilding its economy and repairing the ravages of war. The onus on industry was great and expansion was essential. A survey by the Board of Trade on industrial building sheds light on one aspect of the reconstruction. It shows that since the war more than 10,000 industrial building schemes have been completed, with an aggregate floor space of more than 225,000 sq. ft.

The report underlines the importance of development areas in the post-war development. More than one quarter of all industrial building granted location approval since the war and about one third of that known to have been completed by the end of last year have been in scheduled development areas. Of the 71,560,000 sq. ft. completed, 22,000,000 sq. ft. were financed by the Government. Again, roughly one third of the total completed area was for the engineering and electrical goods industries. About 16 per cent. was for iron and steel manufacture and 13 per cent. for chemicals and allied trades.

FORGROVE MACHINERY COMPANY, LIMITED, Leeds, is to build a two-storey factory and office block on the Seacroft light industrial estate, Leeds. The factory will cover four acres and will manufacture machinery for wrapping confectionery.

Evaluation of Casting Processes*

Discussion of the AFS Exchange Paper by Hiram Brown, B.S.

In the main, contributors to this discussion considered the Author had been over-severe in his criticism of the efforts of precision founders, particularly investment-process founders. Thus many comments were by way of refuting the Author's allegations, though some regarded Mr. Brown's comment more as a stimulant for founders to attempt an improvement in quality. This, the Author makes clear in his replies, was indeed his objective. Considerable weight of opinion suggests that British investment founders may be ahead of their counterparts in the States, and the Author certainly does little to dispel such an opinion, though quoting individual exceptions where good work has been received from American firms.

Introducing the Paper the chairman (Dr. A. B. Everest) explained that Mr. Hiram Brown was the chief metallurgist of the Solar Aircraft Company at Des Moines, Iowa, in the United States, and was a leading expert in light metals and high-temperature alloys and was a specialist in various methods for the production of precision castings, being the author of two books and several papers on this subject. Unfortunately, Mr. Brown was not able to be with them and had asked his colleague, Mr. Johnson, the London representative of Solar Aircraft, to present his Paper " Evaluation of Casting Processes " on his behalf. He was sure members would all be grateful to Mr. Johnson for undertaking that duty.

(The Paper was then presented)

Opening the meeting for discussion, the CHAIRMAN remarked that he had looked through the Paper and regarded it as a very provocative one and challenging to some founders who had developed investment-casting and similar processes. He hoped there would be a good discussion, since all delegates had received preprints of the Paper for study for some time past.

Author's Views Challenged

MR. D. H. ARMITAGE said when reading the Paper he had had the feeling that in America founders were now faced with some of the problems that were tackled in this country about ten years ago. At that time, the steel foundries of this country—and he spoke only of steel castings—were producing parts by orthodox foundry techniques for structural purposes in aircraft; specifications DTD 666 and 705 were devised to cover the inspection procedure for aircraft castings at that time. Since then, several founders in this country, particularly amongst the producers of investment castings, had entered the high-quality castings market and stayed in business. He believed the position in America at the moment was that a committee was sitting to discuss the application of such castings.

As Mr. Brown suggested, the founder wishing to produce high-quality castings, had to have first-class foundrymen on his staff and use high-grade foundry techniques and controls, both in the manufacturing processes and the inspection procedure, including the use of radiographers—who were not completely blind—whether it were investment casting or orthodox sand casting. In that connection Mr. Brown had suggested that castings were suspect because high-quality castings had to be subjected to X-ray examination. When purchasers stopped looking at X-ray examination in that way and accepted it as a normal operation in the production of a first-class casting, just as necessary as melting the steel, then progress would be made. He agreed that this should be the foundry's business and in no way concern the purchaser after the setting of the initial standard.

To turn to detail; there was one particular point in Mr. Brown's Paper on which he would welcome more information. The Author stated that generally sand castings would be sounder and stronger than investment castings. Could he give the materials concerned, the method of casting, and details of the testing on which he based that statement? From personal experience with materials suitable for investment casting—and not all materials were—the properties obtained on centrifugally-cast Tensometer test-pieces had more usually been equivalent to that demanded by the wrought specification for a given material and had, as Mr. Brown pointed out, similar properties in all planes. After Mr. Brown's remarks about overselling, he would hasten to add that the previous statement could be substantiated with figures prepared independently. He agreed, however, that " overselling " did take place initially in investment castings, particularly on the question of tolerances.

The answers to Mr. Brown's problem regarding the use of castings would seem to be contained in his own Paper. In Fig. 6 he showed a complicated austenitic stainless-steel investment casting in satisfactory production by one well-established producer. Perhaps, instead of damning the industry because of the bad castings he had received, now that Mr. Brown had found a reliable supplier, Mr. Armitage hoped he would change his mind and design and specify investment castings, with all their potential advantages, in increasing quantities.

MR. LYON said that the gist of Mr. Brown's

* Paper presented at the International Foundry Congress in June and printed in the JOURNAL, July 28.

Paper seemed to be that castings could be good but were not, and the Author came down heavily against investment casting and shell moulding. Should not the complete title of the Paper be "Evaluation of Casting Processes according to Results Normally obtained To-day"—presumably, in North America? With regard to the statement that castings were "fighting for their life," this did not apply in Britain, where there appeared to be among enlightened engineers a growing realization of the high service which castings, including investment castings, could give when they were made with the fullest regard to requirements.

Aircraft Constructional Castings

Referring to castings for aircraft, Mr. Lyon said that while the Author appeared to be more concerned with investment castings for the power plant, it might be interesting to him to know that Britain had naval aircraft flying using investment castings for main-plane attachments, and Mr. Brown could be assured that these were designed, made and inspected (all by the company which designed the aircraft) with due sense of responsibility for the importance of the application.

A most important factor was the qualification of a manufacturer of investment castings by specific tests, and he would be grateful to know what qualifying test was called for in North America before approval was given to a manufacturer seeking to supply castings for aircraft structural parts. He suggested that perhaps Mr. Brown might have been a little unfair to some suppliers who might not have had sufficiently long or close contact with aeronautical engineering fully to be able to appreciate the severity of the requirements. Even experienced founders might judge that castings with certain small defects should be acceptable, but in aircraft work the decision had to be given by independent authority based on strictly observed tests.

Referring to two castings illustrated in Mr. Brown's Paper, Mr. Lyon found it surprising that, eight or ten lines below Fig. 6 of the pre-print, Mr. Brown asked why castings were required to be radiographed before structural usage. A production engineer might ask "was it really necessary to have that particular shape?" It was also surprising that the Author should have had so much trouble in obtaining satisfactory castings for the part he showed in Fig. 8, and the impression given was that in this case the founder was much less experienced or aware of the standard of requirements than the one who produced the casting of Fig. 6.

Statements in Mr. Brown's Paper had invited strong criticism, but Mr. Lyon thanked him for it and for the line he had taken, as it was perhaps only by being outspoken that he would obtain the quality necessary. He expressed the hope that Mr. Brown's criticism of investment casting and shell moulding would not prove to be a dis-service to these processes by discouraging people from using them or their products. It was no easy task producing the castings to the standard Mr. Brown would need, but Mr. Lyon wished him success in obtaining them.

Educating Engineers

PROFESSOR OVE HOFF (Denmark) thought one of the most important things in Mr. Brown's Paper was his suggestion that time should be devoted to educating engineers in the merits of castings. In his country they had tried to modernize the education of engineers in relation to production technique. They emphasized three inseparable points: choice of material; shape of thing to be made; method of manufacture. If one had chosen a certain material one had to a certain extent limited the production possibilities and method of making and the shape. As a foundryman teaching not only foundry technique, but also trying to train mechanical engineers in foundry methods and how to find out the connection between the three primary factors in construction, he would like to know what had been done in other countries regarding the problem of modern methods in relation to castings: how to make the best choice of material for a particular construction at the time of designing.

That of course, was a long-term programme which was likely to take years before any results were apparent or before there were in industry engineers who would be able to employ such principles to the best advantage. However, even if in the foundry industry a much shorter-term project was worked for and they tried to make the best of what they had to-day in securing a better education for engineers in the possibilities of the casting industry, in this way they could at least secure their industry for years to come.

Shell-moulding Potentialities

The second point to which he would refer was the mention of the shell-moulding process. It really had not been treated quite fairly in the Paper. He knew of many people who had had wider experience with the shell-moulding process than had the Author. In Denmark there were made large numbers of small stainless-steel castings in shell moulds. The material was 18/8 chromium/nickel steel, melted in high-frequency furnaces and cast at comparatively high temperatures. Such castings had a very fine grain and he had not been able to observe any carbon pick-up. Possibly, the short amount of time involved when producing by shell moulding had something to do with it, but it was dangerous to use too much resin, in fact, one had to use as little as possible. Secondly, avoidance of carbon pick-up might be a question of protecting thermally the working face of the pattern before the real shell-moulding resin was applied.

Selecting Appropriate Processes

MR. ADAM DUNLOP thanked Mr. Brown for his Paper and thought he had been intentionally provocative. It was a good thing in these times to be healthily critical, but he thought Mr. Brown had been rather too critical. The speaker had been for some years now concerned in the development of investment processes and the thing always neces-

sary to bear in mind was that it was castings that were desired. Investment techniques were fine for making precise refractories, but it should not be forgotten that it was castings which were the ultimate goal. The metal had to be melted properly and cast at the optimum temperature and correct gating and feeding arrangements had to be devised. Investment castings, by and large, seemed to be sounder than sand castings, which rather contradicted what Mr. Brown had said. There was no reason at all why the casting illustrated should have exhibited porosity—with properly melted metal it would not have been there.

There were two grounds only on which investment castings should be introduced: one applied to practically any alloy if the shape of the component required was complex and expensive to manufacture by other methods. The second was where the use was required of materials and alloys which could not be machined: for example, a complex shape in a cobalt-base alloy could not be made by any other method than investment casting.

He agreed with Mr. Brown that in the past precision castings had tended to be " over-sold," but the real solution was to select an appropriate process for the job in hand.

Fine Grain

Mr. Armitage had raised a pertinent question when he asked on what ground did Mr. Brown make his claim that sand castings were generally stronger than investment castings. Investment moulds were being made to-day that were ideal for the reception of molten metal. They were permeable; they withstood heat shock; they did not spall and could stand anything that was normally required of them in casting but they had just one defect in that the rate of heat diffusion was generally slow, which factor led to large grain-size in the castings. Work was in progress, however, and promising results were being obtained in the treatment of metal actually prior to casting to produce finer grain-size. In moulds where the section was thin an inoculation process could be applied to the mould surface to produce a finer grain-size. The stage had now been reached in the production of precision investment moulds when future work should be directed to the production of higher quality in the casting by better gating techniques and inoculations to produce a finer grain.

Written Comment

THE PRESIDENT then announced that he had received a written contribution from Mr. W. H. Sulzer of Switzerland, which he read.

MR. W. H. SULZER wrote that factors responsible for the quality of an investment casting were:—proper design; good gating-technique; good metallurgical-control, and the application of a suitable casting method. Judging from his remarks, Mr. Brown had apparently encountered a supplier of investment castings, who did not participate in the progress made since the early days of this casting process. It was not quite understandable why he complained about the inability of the investment-casting industry to produce such simple castings as were shown in his Figs. 7 and 8, when in his country many foundries were successfully producing large quantities of aircraft parts to the most rigorous specifications.

To show Mr. Brown that not all investment castings consisted of holes surrounded by a thin layer of metal, Mr. Sulzer directed his attention to the cast wheel for a jet-engine starter, shown in Fig. A, which had been produced in large quantities with very great success. This casting underwent the most severe inspection procedure and its room-temperature properties were guaranteed to the following specifications:—Yield point, 51 tons per sq. in.; ultimate tensile strength 70 to 76 tons per sq. in., and elongation, 10 per cent. minimum.

It was obvious that Mr. Brown's Paper gave a rather distorted picture of the present status of the investment-casting industry. Just as desirable as organizing the industry in the manner recommended by Mr. Brown in his concluding remarks, would be the avoidance influencing the potential customer of investment castings by one-sided views, such as were unfortunately contained in his Paper.

Using Process Potentials

MR. T. H. WEAVER felt it was impossible to reply to, or criticize, all the derogatory statements which had been made. It may be, that the Paper was paying compliments to Britain for the castings made by investment and other processes here. It struck the speaker very forcibly that the Author was dealing with a mass of people who did not have to get their living by producing sound castings upon an economic basis of production. That, however, was far too large a subject to enter upon at this stage, but he would point out to Mr. Brown that one could only get out of an industry what was put in to it. He knew the previous speaker had considerable experience, and had himself carried out much

Fig. A.—Investment-cast wheel for a jet-engine starter.

development work with investment castings. Having been around this country, he would say there was not one iota of truth in the statements made about the results that were presumed likewise to be obtained in this country. The castings made in Britain by investment-process methods were very satisfactory and it did the foundry industry credit to know the performance of the British aircraft that were flying satisfactorily and incorporating many investment process castings in their construction.

Turning to shell moulding, that process again, was dependent on what one put into it. It had been received with a fanfare, as Mr. Brown had said (and that was one of the few things with which the speaker agreed) but, there again, if founders cared to put into shell moulding their very best efforts, they would get optimum results out of it, but the question of cost also entered into it. Shell moulding had its limitations and had yet to be fully developed.

Another point was that no mention had been made of the type of equipment that would have to be paid for and supplied to meet the requirements of Mr. Brown.

Healthy Criticism

MR. E. LONGDEN said that having listened to the summary of the Paper and to the various speakers who contributed to the discussion, he had come to the conclusion that Mr. Brown had actually explained and confirmed most of the remarks of those who had spoken. But, it was most unjust to suggest that Mr. Brown had been unfair to the makers of special-process castings; he had been most courageous and had voiced much that might have been said in Britain a long time ago. Surely, founders were not so thin-skinned that they could not be told that they did not always succeed in producing the 100 per cent. maximum-quality castings. The British foundry industry was producing a good-quality investment casting in this country and he knew that some of his associates had taken an active part in the initial development of the process in Britain and some of them were now producing castings that would even satisfy Mr. Hiram Brown. However, Mr. Brown was probably trying to encourage the making of better-quality castings than he had received in the past.

A word or two might be contributed to the opinion expressed by Mr. Brown on shell moulding. While Britain might not require much more advice on the manufacturing methods for the precision casting process, it was necessary to take stock and avoid failure in the methods used for producing shell-moulded castings. The speaker's duties often carried him about the country and when visiting foundries and questioning about shell moulding was met with " Yes, we are making shell-moulded castings " and taken to a corner of the works where one found shell moulds and some castings, but they were not being produced as an ordinary production line of work. Certain foundries were making quite a success of the process and their staffs had special knowledge of making castings that did not require much machining. But, again, they fail to prove the ultimate economy of the process, except in very special cases. Until he saw better results or clearer propaganda and appreciation of the value of all the ancillary operations and machinery that went to the final making of a shell-moulded casting, he would remain somewhat dissatisfied with the higher claims made for castings produced by the process. He congratulated Mr. Brown on saying what should have been said a long time ago, that shell moulding had been oversold.

Desirable Training

DR. C. J. DADSWELL thought he might make one comment following the remarks of Professor Hoff on the training of engineers, which meant customers, in correct casting design. He supposed in most countries, including this country and in America, the trade associations of the foundry industry had tried to take steps towards educating engineers, by publishing booklets and dealing simply with effects of the change of section, and giving some idea of progressive solidification. His feeling was that they should continue doing that, it was very difficult to expect engineers during their apprenticeship or college years to know very much about casting design. He believed in encouraging the user of the castings —he was always thinking of steel castings in particular when speaking, but it applied to all forms of casting—to collaborate through his design office with the maker of the castings, that is, the founder. He suggested that a foundry should never accept a design to make a casting if it was thought that it could be improved by some modification. Whereas years ago when one did refer those matters back to the firm or designer one sometimes got cold-shouldered, it was found now that there was a willingness to reconsider a project on the part of the designer, if the founder thought it could be improved. The trouble was, of course, that the founder was not always quite sure himself how it could be improved. Although the founders' craft was now more of a science, there was still much of that science which was really " rule of thumb." He certainly thought that in training student engineers they should be told about fundamentals, but their experience in the use of them only came by practice.

He knew little about shell and investment casting, but some of the sentiments expressed by the Author were sound and he thought the foundryman would have to accept in future higher quality standards and make every effort to improve his processing, rather than complain that the qualities demanded were too severe. Demands for quality were always increasing; the engineer wanted to apply higher stresses and to reduce weight and it had to be the engineer and the foundryman who would meet such demands, whatever the metal in which they were working. Then demand would be for castings instead of the competitive processes, which Mr. Brown rightly referred to as undesirable.

Stimulation not Condemnation

MR. WALTER R. JAESCHKE (USA) said he would like to give a few words of explanation about Mr. Brown. He was a friend of the foundryman and had for a long time been chairman of the National Committee of the American Foundrymen's Society's Committee on light metals. In the Paper he was writing from the viewpoint of the purchaser of castings to his friends in the foundry industry with whom he had worked hard. There was no better supporter of the foundry industry and the castings-consumer branch of that industry than the Author, who was writing from that viewpoint and trying to stimulate his foundry friends into doing a better job. As Mr. Longden had mentioned, he was trying to get the foundrymen away from the complacent attitude that they were doing well enough.

THE PRESIDENT (DR. A. B. EVEREST) said he was sure Mr. Brown would be gratified at the vigorous discussion which his Paper had provoked. Closing the discussion, he thought he should refer to the fact that there were in the Institute of British Foundrymen two sub-committees relative to the question under discussion. The had a sub-committee studying the effect of casting design on the soundness and properties of the casting. Secondly, the Institute had from time to time reviewed casting processes from the point of view of accuracy of dimensions of the finished product. It was felt that the very best was not always being made of existing processes, that new methods were not necessarily the answer. The Institute kept this very much in mind in their review so that a proper evaluation of the different methods could be made.

MR. JOHNSON, who had presented the Paper on behalf of Mr. Brown, when thanking the audience for the reception they had accorded it, said it would be of great interest if some account of the rejection ratios on precision castings and of the dimensional limits to which such figures related could be given.

THE CHAIRMAN, winding up the proceedings, particularly thanked Mr. Johnson for having taken on and carried through so well the very difficult task of presenting Mr. Brown's Paper.

AUTHOR'S REPLIES

After receiving a transcript of the comments at the meeting, the AUTHOR (Mr. Hiram Brown) wrote in reply that he was deeply gratified by the courtesy shown by the foundrymen when his Exchange Paper was presented. Their interest, as evidenced by their questions, was most gratifying, and for that reason he proposed to try to answer as completely as possible the questions presented. He was indeed sorry that he was unable to be present in person, because, first of all, he realized that the Paper would be quite provocative and anticipated that a number of "kicks" would be received. He would have preferred to have had them direct, rather than causing his good cohort, Mr. Johnson, to have to be subjected to them. In the second place, this was the second time that he had been accorded the honour of submitting an exchange paper, this being in 1950. It might be interesting for founders to learn that that paper was on the subject of "Investment Castings" and told many of the things that his firm had done to produce better investment castings.

Personal Status

There seemed to be a belief on the part of one or two of the audience that he was "talking through his hat" so far as investment castings were concerned, and that he had never been in the position of having to make a living by selling such items. For those, in particular, he would like to point out that his firm, at one time, operated one of the largest investment-casting foundries in the United States, as a subsidiary of Solar Aircraft Company. It was known as Solar Precision Casting Company. The Author was chief metallurgist of that subsidiary; the firm produced many difficult and complex castings such as those illustrated in the sketches which accompanied these remarks (Fig. B). After

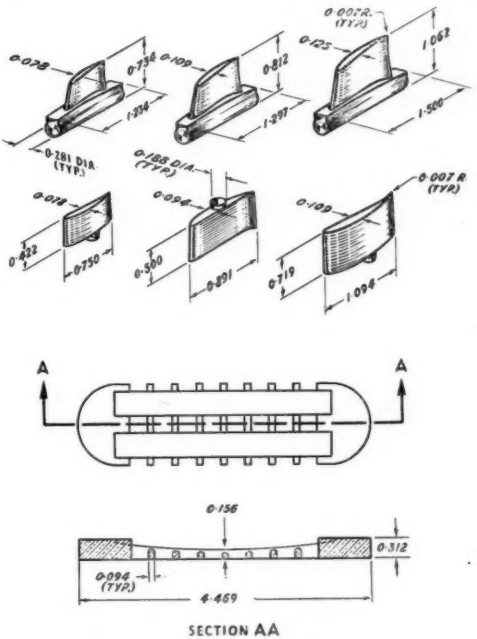

FIG. B.—*Set-up for the manufacture of complicated precision investment castings typical of those handled by the Author.*

the firm closed its investment-casting division to make room for expansion in the jet field, it was unable to obtain some of these parts to the quality standards previously attained, and was forced to re-design the parts which went into Solar proprietary items. He mentioned this only to show that he was cognizant of what problems faced investment founders.

Finding a Yardstick

In all fairness he hastened to assure members that

his Paper was intended to be an evaluation of casting processes in North America, as suggested by Mr. Lyons, and was not an effort, as such, to say that England could do no better. However, before he would agree with Mr. D. H. Armitage and Mr. Lyons that British founders had successfully overcome these problems, there would be a number of factors which he would have to consider. The fact that England apparently did not have difficulties such as those which he mentioned could come from a number of other reasons than any superiority of British casting techniques. For example, he suggested four factors which would have to be evaluated:—

1. Were British casting techniques better, or did firms in North America push quantity of production more than did the British?

2. Had the British learned to use more sensible designs than the Americans so that castings were used only where they were commercially feasible?

3. Did firms in North America try to use too many alloys instead of standardizing on a smaller number of alloys which had been proved for quality, performance and foundry characteristics?

4. Were different quality-standards used by Britain and North America?

Before he would agree that North America was doing a worse job of casting than Britain he would want to examine tolerances, shapes, quantities, quality standards, actual X-ray negatives of parts, and test results of specimens taken from investment castings.

He pointed out that Mr. Armitage had misquoted in saying "Mr. Brown stated that generally sand castings would be more sound and stronger than investment castings." Actually on page 8 of the preprint he said: "Investment-cast tensile specimens in many cases show lower strength than similar sand-cast specimens." However, he would like to answer the speaker's question concerning the circumstances that verified this statement. His firm bought a tremendous number of 18/8 stainless castings of all sorts. The coarse grain-size, porosity, and other soundness defects had consistently given poorer properties than sand castings of similar alloys. That did not mean that the firm had not had good investment-cast test specimens, but the average had been much poorer than those sand cast. He did not think any foundryman would argue the fact that where casting defects were common, properties would tend to be poor in many instances. When his firm was investment casting non-ferrous metals, it was found that with aluminium alloys such as 355 (5 silicon, 1.3 copper, and 0.5 magnesium per cent.) and 356 (7 silicon, 0.3 magnesium) alloys, as-cast test-specimens from investment and sand moulds respectively were comparable in properties, but in many cases the investment-cast alloys would not satisfactorily respond to solution heat-treatment and ageing. Also, in casting 40E aluminium (5.5 zinc, 0.5 magnesium) the as-cast or naturally-aged test-bars of investment and sand moulds would be comparable, but the investment-cast specimens would not artificially age in many cases. This might have had something to do with the grain structure and slow cooling in the investment mould, but, regardless of this, it was found that those difficulties were frequent.

The same speaker further stated that from his own experience, "with materials suitable for investment castings and not all materials were—the properties obtained on centrifugally-cast Tensometer test-pieces had more usually been equivalent to that demanded by the wrought specification—." Perhaps his statement that not all materials were suitable for the process contained the answer to the apparent difference of opinion. Maybe firms in North America were trying to use many materials which should not properly be made into castings. This went back to the design study and it must be remembered that at the Author's plant, as sub-contractors, they could only buy and test parts to the specifications designated by the aeronautical engineers who designed those parts.

Back-street Plants

Mr. Armitage also stated that since a reliable supplier had been found of the complicated casting shown by Fig. 6 of the Paper, that the Author might now be much more willing to specify investment castings. Unfortunately, this was not so since he had had to try four sources before locating one which could make those parts. Due to the high production quantities required by this concern, and the fact that normally it could not be content with a single source but it required to have two or more sources for a particular part, it would have a difficult time indeed if the firm "rested on the oars" because one foundry had been successful. Unfortunately one found in North America that many small "back-street shops" set themselves up for investment casting business without an adequate background of foundry experience of any kind, and without the technical staff necessary to produce high-quality castings. It was these shops which led to much of the trouble.

It was true to state that the Author would be one of the first to admit that the castings shown in Fig. 6 of his Paper were a "nightmare" for any foundry, but that was the way the designer drew it for casting purposes. He had already admitted that Mr. Lyons was correct concerning the fact that he should have made it clear that his comments were confined to North America. He would like to assure him that he was not exaggerating when saying that castings were in many cases "fighting for their life" in America. The examples he gave were not isolated cases, but could be repeated many times over. He might add that before making some of his sweeping comments he had checked with many of the prime engine manufacturers and found that they were faced with many of the problems outlined. One of the worst problems facing the users of investment and shell-moulded castings was the cracking that occurred along coarse-grain boundaries during welding. It had been possible in some instances to overcome this difficulty by extremely slow

welding, but, because of the high production required by American economy, firms did not normally welcome any trend in this direction. He could introduce Mr. Lyons to a large number of engineers in the aircraft industry who would immediately rule out any suggestion of castings because of previous difficulties with them.

Mr. Lyons raised a very good question when he asked, " What qualifying test was enforced in North America to prove a manufacturer of aircraft structural parts? " His comment was also pertinent when he stated that, " Beyond all doubt all available methods of inspection implied some examination also of the background and training of the personnel involved." The Author had already commented briefly on the fact that many back-street shops had unqualified personnel. That was certainly a fact which he weighed very strongly in investigating any potential vendor of castings. Generally, American aircraft firms were careful to make actual breakdown tests of parts before approving them for use, however, it was found many times where someone simply decided that a part should be made as a casting and arbitrary specifications were applied without actual testing of the parts to see if the quality specified was excessive for the task that the part must perform. This undoubtedly led to high rejection rates, and many cases where the rejected parts might actually be perfectly satisfactory for the use in question. This again emphasized his comments concerning the necessity of training engineers to think of castings in terms of castings and not simply as a substitute or a shape.

Unreliable Suppliers

Mr. Lyons had suggested that perhaps the Author was a little unfair to some of the suppliers who might not have been aware of the quality that was required in aircraft work. Because of his long experience in the foundry industry, he (Mr. Brown) was well aware that the standards now demanded were far in excess of those normally encountered. For that reason, firms consulted with each prospective vendor in advance and outlined for him the quality standards, showed him X-ray prints with both satisfactory and unsatisfactory parts, and in general discussed the functions that the parts would have to perform. Despite all this preliminary groundwork, many of the foundries would turn right around and send parts which even a ten-year-old could see, by comparing X-ray prints, were completely unacceptable. In many cases where parts were rather complex and standards were very tight insofar as small defects were concerned, firms went so far as to select actual castings to serve as standards for acceptable, borderline, and unacceptable parts; but, even this, in many cases did not impress the vendor.

As to Mr. Lyons' comments about Fig. 6 on page 7 of the preprint, asking whether it was really necessary to have that shape, as previously indicated he agreed that so far as the foundryman was concerned this was a monstrosity and he certainly wished more engineers would have asked that same question. Mr. Lyons also referred to Fig. 8 which he stated should have been an easy casting to make, without any difficulty. He agreed completely but the fact remained that his firm was constantly in difficulty with them where quality was concerned. He thought the reason was not because the casting could not have been made sound, but the fact that the vendor was too interested in the number of parts per mould rather than the quality of the individual parts. In Mr. Lyons' concluding sentence he had very accurately interpreted the Author's motives when he stated, " Possibly he wanted to tell everyone who took up investment casting and shell moulding that they should go into it most carefully and thoroughly." That was precisely the cardinal point and it was intended to apply not only to those who proposed to go into the business of making castings of this sort but to those who intended to design or use such castings.

The remarks of Professor Hoff concerning the education of engineers were most profound and he was certainly in agreement with them. Prof. Hoff pointed out that possibly the use of too much resin in the shell moulds contributed to the carbon content on the surface of the castings mentioned in the Paper. He thought he was quite correct and unfortunately the trend for a while in America had been towards increasing amounts of resin. The speaker's suggestion of protecting the face of the pattern before the shell moulding mix was laid against it, sounded an excellent notion when such troubles with high carbon were being encountered. European experience with shell moulding preceded American, and their techniques might thus be further advanced. He would be interested in seeing some 18/8 stainless castings having fine grain without the presence of either titanium or columbium (niobium) in the metal. He would think that the very nature of heat dissipation due to slow conductivity would encourage coarse grain-size in these materials.

Mr. Dunlop had made many fine comments but he thought his attitude might have been somewhat prejudiced due to association with the " development of investment processes of one sort and another." Those who were pushing new ideas did not often take kindly to any criticism of the method in question. The Author was sorry that Mr. Dunlop felt that he was being too critical, but disagreed with him when he said that investment castings by and large were sounder than sand castings. He had discussed this previously, and hoped that Mr. Dunlop would refer to that discussion. He agreed with the speaker that there was no reason at all that the casting illustrated should have had objectionable porosity. The point was that it did have the defect, and, therefore, something must have been wrong.

Again he would like to repeat for Mr. Dunlop's benefit that he did not say in his Paper that sand castings were generally stronger than investment castings. However, Mr. Dunlop threw some doubt on his own defence of investment castings when he stated that investment moulds to-day were being made which were ideal for the reception of molten metal *except* that they led to large grain-size. This could be a most serious defect in so far as strength

and weldability was concerned. He would agree with his suggestion that future work could well be directed towards the production of higher quality metal, better gating techniques, and inoculation to produce a finer grain.

The Author was very sorry that Mr. Weaver so strongly considered his statements derogatory. However, he did not believe that Mr. Weaver and himself were really as far apart as it would seem. He believed that the apparent differences came from the fact that Mr. Weaver had not read and analysed the Paper closely enough. If he had followed the statements closely he would have found that there was perfect agreement that one only got out of any process what one was willing to put into it. At no time did the Author say that the difficulties encountered with shell and investment castings could not be overcome. He insinuated that not enough effort was being expended to overcome the difficulties in order to bring out the best possible quality inherent in the various processes.

He was not sure what Mr. Weaver meant by his statement that "They were dealing with a mass of people who did not have to get their living by producing sound castings on an economic basis of production." If he was referring to the Author, it would seem that the opening comments concerning the writer's past experience in the investment casting business would answer that question.

Mr. Longden indeed deserved the Author's eternal gratitude for his comments, as he understood the Author's purpose very accurately, and his comments on experiences encountered in visiting the various foundries were certainly similar to personal experience in North America. The comments of Dr. Dadswell were most welcome and most enlightening. It was heartening indeed to have him lend support to many of the ideas expressed in the Paper. The Author also expressed his thanks to Mr. Jaeschke (USA) for his statement concerning his qualifications to discuss the subject in question. It was very much appreciated, but he certainly hoped his British friends did not have the impression that he objected to any good, healthy criticism of anything that he said. He was sure from the tone of their comments, as evidenced by the typescript, that all of those who commented on the Paper did so in a most friendly and constructive manner.

The Author had endeavoured to answer all of the questions put forward, but if he had left any unanswered he hoped that the individuals concerned would feel free to write him to carry on the discussion.

ADDENDUM

MR. HIRAM BROWN further wrote in reply to Mr. Sulzer as follows:

He took exception to Mr. Sulzer's comment that he had given a rather distorted picture of the present status of the investment-casting industry. Unfortunately, he had not. The examples which were quoted could be thoroughly verified at the Author's plant and represented only a portion of what had been encountered in recent years. If his comments influenced potential customers of investment founders to avoid using the process it might be exactly what was needed to get the investment casting people straightened out. He hoped that Mr. Sulzer, in accusing him of one-sided views, would take into account the fact that he did a considerable amount of investment casting himself and he knew what could be done with the process. He also knew how easy it was to get off on the wrong track with the process.

Mr. Sulzer commented that he (Mr. Brown) had apparently encountered a supplier of investment castings who had not participated in the progress made since the early days of this process. Here Mr. Sulzer was in error only in the fact that he did not say suppliers instead of supplier, since the Author's firm found a number of such firms who would fall in line with his description.

He was amazed that Mr. Sulzer did not understand his complaining about the inability of the investment-casting industry to produce such simple castings as those shown in Fig. 7 and 8. The very fact that they were simple is what made him complain. If Mr. Sulzer would read the Paper carefully he would note that full credit was given to the company which had satisfactorily cast the complicated and difficult casting shown in Fig. 6 of the Paper.

Mr. Sulzer directed attention to the cast wheel for a jet-engine starter which had been produced in large quantities with very great success by investment casting. He too could also pick out some very fine parts which had been made by investment casting. Unfortunately, when one bought parts in the quantities purchased by the Author's firm, those become the exception rather than the rule. As pointed out in the previous discussion, it may be that the British founders are more advanced in their technique than founders in North America but he would still examine very carefully any claims made concerning the very high quality consistently encountered with investment castings anywhere. There were many factors which could affect this problem, and he would certainly subject the parts and applications to close scrutiny before agreeing with Mr. Sulzer's comments.

He thought it was indeed unfortunate that Mr. Sulzer felt so strongly opposed to his (Mr. Brown's) ideas. Perhaps this was because such forthright statements are not usually made and they might have been somewhat of a shock to him. He should like to reassure Mr. Sulzer, however, that he was ready at any time, by means of case-histories and examples to substantiate the comments which he had made in the Paper.

INDUSTRIAL OUTPUT in Germany declined from the index figure of 209 in June (1936 = 100) to 199 in July. This was due to seasonal influences which were, however, stronger this year than last, the fall being only 4 per cent. in 1954 against 5 per cent. this year. The volume of output was 15 per cent. above the level of July last year. Output of capital goods was 24 per cent. higher than in July, 1954, that of basic industries 14 per cent., and of consumer goods industries 11 per cent.

Ironfounding Expansion Continues

Total Output

The UK output of iron castings for the first half of 1955, at 2,014,140 tons, was an all-time record for the industry, and the first half-year in which the two million-ton mark has been passed. In the second quarter of 1955, production was 7.7 per cent. higher than in the second quarter of 1954. In the first quarter it was 5.4 per cent. above the corresponding 1954 level. The rate of advance over 1954 is therefore increasing. There was a 2 per cent. fall in output from the record first quarter level less than would normally result from holidays. In addition, there were difficulties caused by the rail and dock strikes.

Main Sections

The outstanding expansion in automobile castings production continued. In the second quarter, output of these castings was 29 per cent. more than in the second quarter of 1954. The section of the industry, which makes castings for the engineering industry generally, was operating at nearly 10 per cent. above

TABLE I.—*Output of Iron Castings, by Sections.*

Section. (Grey and malleable iron castings.)	Tons. 1954 Second Quarter.	Tons. 1955 Second Quarter.	Percentage change.
Automobile (including tractors) ..	109,680	141,450	+29.0
Engineering and jobbing ..	336,340	368,630	+ 9.6
Building and domestic	137,850	147,640	+ 7.1
Ingot moulds	85,620	91,050	+ 6.3
Pressure pipes and malleable tube-fittings	175,340	178,700	+ 1.9
Railway equipment	80,930	69,130	−14.6
Total	925,760	996,600	+ 7.7

the corresponding 1954 level. Production of ingot moulds, pressure pipes and building and domestic castings was also higher than a year ago. Railway castings production continued at below the 1954 level, as the result of reductions in the output of chair castings. Table I shows the output of iron castings in the second quarter of 1955 for each of the six main sections of the ironfounding industry, compared with the corresponding quarter of 1954.

TABLE II.—*Pig-iron and Scrap Consumption by Foundries.*

—	Tons. 1954 Second Quarter.	Tons. 1955 Second Quarter.	Percentage increase.
Pig-iron (including refined iron) ..	578,210	624,220	+8.0
Iron and steel scrap (about half is foundry circulating scrap) ..	741,780	790,040	+6.5

District Production

The expansion of output was more evenly distributed. Of the 22 ironfounding districts, only Cumberland and the N.E. Coast showed decreases compared with the second quarter of 1954, and these were only fractional. Previously, much of the expansion has been concentrated in the West Midlands, but in the second quarter more of the other areas were also producing at well above the corresponding 1954 rate.

Raw Materials

The Ironfounding industry's consumption of its principal raw materials is shown in Table II. A serious stringency in supplies of hematite pig-iron, aggravated by the rail strike, caused a sharp fall in foundry stocks of this quality during the second quarter. Stocks of other pig-iron qualities rose, despite the dislocation of deliveries during the rail strike, which finished only a fortnight before the end of the quarter.

Labour

The number of persons employed in the industry at July 2 was 143,849, which is 891 less than at the beginning of the quarter. This slight fall has been fairly general throughout the country and is a normal seasonal movement.

More Pay for More Workers

During July, 478,000 workpeople received wage increases estimated by the "Ministry of Labour Gazette" at £93,000 a week. In the first seven weeks of this year, 10,680,000 have gained increases averaging £4,200,000 a week. In the same period last year 7,800,000 workers had rises of £2,450,000 a week. The weekly wage index in July (June, 1947=100) rose by one point to a new peak of 153, but the retail price index remained unchanged at 150.

Industrial disputes cost 88,000 working days in July, only a fraction of the 1,330,000 days lost in June, but 8,000 more than in July, 1954. About 34,700 workers were involved, of whom 9,500 were miners. In the first seven months of this year 2,895,000 working days have been lost by disputes involving 454,900 men. In the same period last year 772,000 days were lost by strikes involving 220,200 men.

During 1954 the number of young persons under 18 entering employment was 505,000, compared with 551,000 in 1953. One third of the boys under 16 entered employment leading to apprenticeships in skilled crafts.

An important change between last year's figures and those for 1950-51 was the increase from 3 per cent. to 5 per cent. in the proportion of boys aged 15 entering the mining and quarrying industries.

UK Industry on Show at Copenhagen

Between them, Denmark, Finland, Norway, and Sweden represent the United Kingdom's second best export market after Australia. But in these markets there is fierce competition from Western Germany and in Sweden, particularly, Britain has lost ground in the last few years. The main purpose of the British Exhibition, which is to be opened by King Frederik of Denmark in Copenhagen on September 29, is to encourage British exports in Scandinavian countries. When a similar fair was held in Copenhagen in 1948, it attracted 980,000 visitors.

Displays at the fair, which will be open until October 16, will cover more than 115,000 sq. ft., divided between two sites—the Forum and the Tivoli Gardens. Sponsored by the Federation of British Industries and the British Import Union of Copenhagen, the exhibition has been organized by British Overseas Fairs, Limited, and the comprehensive display of products of more than 600 firms ranges from heavy engineering to fancy goods.

Pig-iron and Steel Production

Statistical Summary of June Returns

The following particulars of pig-iron and steel produced in Great Britain are from statistics issued by the British Iron and Steel Federation. Table I summarizes activities during the past six months. Table II gives production of steel ingots and castings in June, and Table III, weekly average production of finished steel. Table IV gives the production of pig-iron and ferro-alloys in June, 1955, and furnaces in blast. (All figures weekly averages in thousands of tons.)

TABLE I.—*Iron and Steel Price Index and General Summary of Pig-iron and Steel Production.*

Period.	Price Index, 1938 = 100.			Iron-ore output.	Imptd. ore used.	Coke to blast-furnaces.	Pig-iron, ferro-alloys prod.	Scrap used in steel prod.	Steel (incl. alloy).			
	I. & S.	Coal.	all comdts.						Imports.[1]	Prod. ingots, castings.	Delvrs. finished steel.	Stock.[2]
1953	260	350	323	304	207	237	215	188	17	339	262	962
1954	263	364	325	299	234	238	229	198	7	356	277	831
1955—Jan. ..	268	373	333	303	243	240	236	213	11	381	298	828
Feb. ..	269	373	334	315	246	242	242	220	17	394	314	812
Mar.[3] ..	269	374	331	322	239	244	241	225	28	395	321	808
April ..	269	374	329	310	234	242	238	224	29	393	311	844
May ..	269	367	328	313	245	242	242	228	26	402	324	859
June[3]	269	368	331	263	223	221	217	206	31	—	—	866

TABLE II.—*Production of Steel Ingots and Castings during June*, 1955.

District.	Open-hearth.		Bessemer.	Electric.	All other.	Total.		Total ingots and castings.
	Acid.	Basic.				Ingots.	Castings.	
Derby, Leics., Notts., Northants and Essex ..	—	4.0	11.1 (basic)	1.9	0.2	16.2	1.0	17.2
Lancs. (excl. N.W. Coast), Denbigh, Flints. and Cheshire	1.0	28.5	—	2.2	0.4	30.8	1.3	32.1
Yorkshire (excl. N.E. Coast and Sheffield) ..								
Lincolnshire	—	36.1	—	—	0.1	36.0	0.2	36.2
North-East Coast	1.0	74.2	—	1.4	0.5	75.1	2.0	77.1
Scotland	2.6	37.1	—	2.0	0.4	40.2	1.9	42.1
Staffs., Shrops., Worcs. and Warwick	—	17.7	—	1.1	0.8	17.8	1.8	19.6
South Wales and Monmouthshire	4.6	71.7	6.3 (basic)	1.2	0.1	83.2	0.7	83.9
Sheffield (incl. small quantity in Manchester) ..	8.1	30.7	—	10.7	0.4	48.0	1.9	49.9
North-West Coast	—	1.7	4.7 (acid)	0.4	0.1	6.0	0.1	6.1
Total	17.3	301.7	21.3	20.9	3.0	353.3	10.9	364.2
May, 1955	22.9	328.0	25.0	22.5	3.2	390.1	11.5	401.6
June, 1954[3]	20.0	306.2	24.6	17.6	3.3	361.6	10.1	371.7

TABLE III.—*Production of New Non-alloy and Alloy Finished Steel.*

Product	1953.	1954.	1954.	1955.	
			May.	April.	May.
Non-alloy steel :					
Ingots, blooms, billets and slabs[4]	4.7	5.1	5.3	5.0	5.5
Heavy rails ..	8.7	9.6	10.5	10.1	10.8
Sleepers, etc. ..	2.2	1.9	2.4	3.6	1.2
Plates, 3 mm. thick and over ..	46.5	47.0	50.4	48.4	50.0
Other heavy prod.	43.9	45.8	48.1	49.1	49.3
Ferro-con. rods, etc.	5.1	5.9	5.7	7.1	7.9
Wire rods and other rods	15.6	19.7	20.7	23.0	23.4
Light rolled prod.	44.2	41.2	40.9	45.3	51.2
Bright steel bars ..	6.7	6.3	6.2	7.6	8.1
Hot-rolled strip ..	18.8	21.7	23.4	24.6	25.4
Cold-rolled strip ..	5.2	7.0	7.1	7.3	8.5
Sheets, incl. coated	34.1	38.8	43.4	44.9	45.8
Tin, terneplate and blackplate ..	14.9	16.8	17.0	16.6	16.8
Steel tubes, pipes..	20.1	20.0	21.9	21.8	25.4
Tube, pipe fit'gs. ..	0.3	0.4	0.4	0.4	0.5
Tyres, wheels and axles	4.4	4.7	4.8	5.3	4.8
Forgings (excl. drop forgings) ..	3.1	2.6	2.8	2.6	2.6
Steel castings ..	4.0	4.0	3.8	4.0	3.5
Tool and magnet steel	0.3	0.2	0.2	0.3	0.4
Total	282.9	298.7	315.0	327.0	341.1
Alloy steel	13.7	13.2	13.8	14.9	16.0
Total deliveries from U.K. prod.[5] ..	296.5	311.9	328.8	341.9	357.1
Add : Imported finished steel ..	6.8	5.0	2.2	16.7	18.0
	303 3	316.9	331.0	358.6	375.1
Deduct: Intra-industry conversion[6] ..	42.6	41.5	44.3	50.1	52.6
Total net deliveries of new material ..	260.7	275.4	286.7	308.5	322.5

TABLE IV.—*Production of Pig-iron and Ferro-alloys during June*, 1955.

District.	Furnaces in blast.	Hematite.	Basic.	Foundry.	Forge.	Ferro-alloys.	Total.
Derby, Leics., Notts., Northants and Essex	25	—	15.5	24.4	1.0	—	40.9
Lancs. (excl. N.W. Coast), Denbigh, Flints. and Cheshire ..	6	—	12.6	—	—	1.2	13.8
Yorkshire (excl. N.E. Coast and Sheffield) ..	—	—	—	—	—	—	—
Lincolnshire ..	10	—	32.9	—	—	—	32.9
North-East Coast	22	4.3	46.8	—	—	1.4	52.5
Scotland	9	—	12.1	2.3	—	—	14.4
Staffs., Shrops., Worcs., and Warwick ..	7	—	8.4	1.3	—	—	9.7
S. Wales and Monmouthshire	9	4.0	32.4	—	—	—	36.4
Sheffield	1	—	1.9	—	—	—	1.9
North-West Coast	7	12.7	—	0.1	—	1.5	14.3
Total ..	96	21.0	162.6	28.1	1.0	4.1	216.8
May, 1955 ..	99	26.4	178.8	31.6	1.2	3.8	241.8
June, 1954[3] ..	102	27.9	172.9	27.8	0.9	3.7	233.2

[1] Weekly average of calendar month.
[2] Stocks mainly ingots and semi-finished at the end of the years and months shown.
[3] Five weeks, all tables.
[4] Other than for conversion into any other form of finished steel listed
[5] Includes finished steel produced in the U.K. from imported ingots and semi-finished steel.
[6] Material for conversion into other products also listed in this table.

Exhibition Briefs

Below are recorded further brief reviews of stands at the Engineering, Marine and Welding Exhibition and Foundry Trades Exhibition currently being held at Olympia, London; hours of opening: 10 *a.m. to* 8 *p.m., excluding Sunday (exhibition closes September* 15).

THE LIST of exhibits of Air Control Installations, Limited (stand 29, outer row gallery, Grand Hall) include the Rotoclone for wet or dry collection; a Dusgard unit for stand grinders; air filters; an air-conditioning unit; fans; small blowers; a humidifier; a dryer and equipment for pneumatic conveying, the latter illustrated by a working model.

VISITORS—particularly those from overseas—are encouraged to call at the stand of the British Engineers' Association (stand H, row 2, Grand Hall). The staff direct visitors, quickly, to displayed equipment in which they express interest. Experience at past exhibitions has shown that there is a wide range of services supplied by this information centre which are of assistance to stand-holders.

THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH (stand 3, row K, ground floor, Grand Hall) are showing modern crane controls in the section devoted to the British Iron and Steel Research Association. A full-size modern crane cab is there, together with an old-fashioned type to show the effect of an improved layout in which the controls are made to fit the man, in accordance with the principles of ergonomics.

BALDWIN INSTRUMENT COMPANY, LIMITED (stand 2, centre row, gallery, National Hall), is exhibiting a variety of pneumatic equipment representative of the hundreds of standard units now available. The models include double-acting air cylinders; directional control valves, and solenoid valves. Working models are included, demonstrating how the equipment is used in practice.

MARTONAIR, LIMITED (stand 25, outer row, National Hall gallery), are exhibiting a hoist—capacity 120-1,000 lb.; maximum lift 30 ft., having an infinitely variable speed from creep to maximum and the advantage of balance effect, whereby the load can be moved a few inches manually without operating the control. A selection of air cylinders are also shown as well as controlling valves and a lathe tool-magazine, the latter for many purposes taking the place of a turret.

INTERESTING new ultrasonic apparatus is the main feature of the Mullard stand (National Hall, inner row gallery, No. 17) at the exhibition. High-power industrial ultrasonic machining and cleaning equipments will be demonstrated alongside the more familiar Mullard drilling and soldering equipment. The 2-kw. ultrasonic machine-tool equipment demonstrated is designed for carrying out all normal production machining processes (drilling, milling, lapping, etc.) on hard and brittle substances.

THE MOND NICKEL stand (number 2, row G, ground floor, Grand Hall) is devoted to properties associated with the products of the company. Amongst these are the properties of s.-g. iron, the physical properties of the nickel/iron alloys and the low-temperature properties of nickel-alloy steel. There will also be exhibits featuring protective finishes. Demonstrations include magnetostriction, temperature control, resistance to creep, and one to show that s.-g. iron has a high modulus of elasticity and can be bent, twisted or struck without failure.

BAKELITE, LIMITED, on stand 13, row A, Grand Hall (just inside the foundry section), devote their exhibit entirely to materials for the foundry trades. Of particular interest is a display on the back panel, showing by exhibits, samples and photographs, the making of shell moulds and cores by the pre-coated sand and dry-mix processes. There are also examples of moulds and blown cores in both types of sand, a core produced by using a phenolic liquid corebinder and an example of stack moulding, using shell moulds. The materials include powdered resins, resins for coating sand, adhesives for shell assembly, parting agents, wetting agents and liquid phenolic and urea resins for bonding cores.

FILMS are being used to demonstrate dust and fume suppression by the Dustuctor Company, Limited, of Hayle, Cornwall, which firm makes its first public appearance on stand 18, row A, in the Grand Hall. The display will interest all founders—particularly the iron and steel industries—in view of the regulations coming into force in the New Year. Examples of the Dustuctor low-volume, high-velocity system of dust and fume extraction are shown, as well as displays of Dustuctor cowls fitted to pneumatic and electric portable and bench grinders. In a special booth, electric radial and surface grinders are demonstrated, and there is an illumination system showing the efficacy of the system by working tests. The system is also shown as applied to pneumatic hammers in fettling or other dusty operations. Methods of fume extraction from a crucible can be seen.

THE PROMINENT PART which is played by research, technical control and craftsmanship in the development and production of the firms' products has been given special emphasis on the combined stand of Eyre Smelting Company, Limited, and their associates, Fry's Metal Foundries, Limited (stand 9, row N, National Hall, ground floor). Some of the research which is carried on is demonstrated on the stand. A centrifugal casting machine shows a method of casting white metals into rubber moulds, a process not very widely known to the engineering industry but one which is almost universally used in the casting of imitation jewellery. Further exhibits include white metals for bearings, Ariel and Esco chill-cast phosphor-bronze and gunmetal rods, Rotocast (true centrifugal castings), bronze bushes, foundry ingots, and Eyre aluminium alloys, and zinc elements for electric cells. A number of castings produced in these alloys, together with finished products in which they are used, are also shown.

THE RUSSO-BRITISH CHAMBER OF COMMERCE, a joint Anglo-Soviet organization incorporated in 1916 under the ægis of the Association of British Chambers of Commerce, has taken a small stand (ground floor, Grand Hall, No. 1, Row K)—it is understood to be the first occasion that a Chamber of Commerce has ever participated in a trade exhibition, other than perhaps at local events. The stand has been set up with a view to stimulating the interest of British traders in the general potentialities of trading with the Soviet Union and to serve as an enquiry bureau to those seeking information as to the prospects for their particular lines. Prospects of improving trade with the Soviet Union appear to be good. Already in the first six months of this year exports from the UK to the USSR have been double those of the corresponding period last year (£7,839,775 as against £3,930,094). This year's figures include machinery (other than electric) £2,936,250, and electric machinery, apparatus and appliances £1,121,292.

["Stand Fifteen" (row A, ground floor, Grand Hall) is the Foundry Trade Journal stand.]

News in Brief

KODAK, LIMITED, Wealdstone, Middlesex, are showing a wide range of their products at the Copenhagen Fair, which opens on September 29.

W. J. HOOKER, LIMITED, announce that on September 12, their address will be 239a, Finchley Road, London, N.W.3. The telephone numbers are to be SWIss Cottage 3281/2/3.

AT A CEREMONY RECENTLY, the hundredth excavator for Canada made by Thomas Smith & Son (Rodley), Limited, Rodley, Leeds, was "speeded on its way" by Mr. Donald Kaberry, Parliamentary Secretary to the Board of Trade.

BRITISH INSTITUTE OF MANAGEMENT is holding its national conference in Harrogate from November 2 to 4. The theme of the conference is to be "Science and Management." Details are available from 8, Hill Street, London, W.1.

BRITANNIA IRON & STEEL WORKS, LIMITED, in co-operation with their associated company—S. A. George Fischer of Schaffhouse—organized the visit of 13 children of long-service personnel to Switzerland as the guests of the two companies.

WILKINSON RUBBER LINATEX, LIMITED, Camberley, Surrey, have obtained an order for 144 rubber-lined centrifugal pumps for the Argentine in the face of international competition. The pumps will be used by the Argentine mining industry for handling abrasive slurries.

JOWETT CARS, LIMITED, formerly of Idle, Bradford, are now operating from new premises at Howden Clough, Birstall, Batley. The firm will continue to distribute spares for post-war Javelin, Jupitor and Bradford vehicles and also reconditioned major units will be supplied.

ROLLS-ROYCE, LIMITED, Derby, have announced that a Conway aero-engine has completed a British Government type-test at 13,000 lb. thrust. The engine incorporates the by-pass principle and has the lowest specific fuel-consumption of any type-tested jet-engine. One of the aircraft it will power is the four-engined Vickers V.1000 military transport.

THE BOARD OF Peglers, Limited, announce that negotiations have been concluded to acquire a majority holding in the Galt Brass Company, Limited, of Galt, Ontario, Canada. This company is similar to their own and has been established in the Canadian market since 1907. The directors are confident that this broadening of the company's activities will ultimately be of great benefit to all shareholders.

NEW PREMISES for the Assay Office in Leopold Street, Sheffield, are to be constructed, by the Guardians of Wrought Plate, on the corner of Portobello and Holland Street, Sheffield. The Sheffield Assay Office was established in 1773 under Act of Parliament. It was originally situated in a house in Norfolk Street, and then in Fargate on the site of the present Yorkshire Penny Bank.

FIFTY YEARS OF PROGRESS since the incorporation the company in 1905, was celebrated by Samuel Thompson & Company, Limited, of Millfields, near Wolverhampton, on August 27, with a jubilee dinner for employees at the Mount Hotel, Tettenhall Wood. It was also the occasion of the presentation of silver wristlet-watches to 41 employees who had completed over 25 years' unbroken service with the firm.

GOLD WATCHES have been presented by Holman Bros., Limited, mining-machinery makers, of Camborne (Cornwall), to more than 100 employees and pensioners who have each completed 40 years' service, or more, with the company. In addition, 18 others, each with 50 years' service, were given cheques. The company has recently contracted to supply civil engineering equipment worth £34,000 to the Konstruktor and Kokin-Brod organizations in Yugoslavia.

PROTESTS have followed the rejection of the bid of the English Electric Company, Limited, to supply generators and transformers for the Chief Joseph Dam project in the United States. Although the company submitted the lowest bid, the contract was awarded to the Westinghouse Electric Corporation and the Pennsylvania Transformer Company under the Buy American Act, on the grounds that the contract would be carried out in the Pittsburgh district where it would relieve unemployment.

LAYCOCK ENGINEERING, LIMITED, Sheffield, have been granted an industrial development certificate to build a new factory occupying 300,000 sq. ft. on a site opposite their Victoria works in Archer Road, Millhouses. The work will cost £500,000, and is part of a £1 million plan designed to double the production of the firm. Work on an extension costing £90,000 and occupying a further 25,000 sq. ft. has already begun. Further additional premises have been acquired from Millspaugh, Limited, in Liverpool Street, Attercliffe, Sheffield.

BORAX CONSOLIDATED, LIMITED, announce that as from October 1 the prices of all their boron products will be increased by amounts ranging from £1 to £1 10s. per ton. In recent years, price increases have been almost entirely due to increases in transit costs and it is some time since there has been an adjustment of this kind, due to steadily increasing mining and production costs, particularly wages. During September orders for reasonable quantities will be delivered at the old prices, with first call to contract buyers.

ENGLISH STEEL CORPORATION, LIMITED, despatched from their Grimesthorpe Works, Sheffield, on August 25, the largest railway casting of its kind ever made outside America. It was a 25-ft.-long cast steel bogie frame made for the New South Wales railways and is a feature of many new-type 2,700-h.p. locomotives which the Australian railways are now having made. The bogie frame, 8-ft.-wide and weighing about 9 tons, was taken from Sheffield by road to the Manchester works of Metro-Vickers, Limited. It is part of a £250,000 contract.

ORDERS to supply boiler fittings for five ships building in Italy have been secured by Cockburns, Limited, valve manufacturers, Glasgow, in face of strong foreign competition. The firm will supply mountings for three tank steamers of 31,500 tons dw. building by the Ansaldo Soc. per Azioni, Genoa, for Palmero and Genoa owners. A second contract is the main steam control units for two similar vessels of 19,000 tons dw. under construction for Italian owners by the Cantieri Riuniti della' Adriatico, Monfalcone. The order is for steam control units of multiple type recently developed by the company.

PRICES OF HOME-PRODUCED STEEL in Australia have been increased by an average of 5 per cent., announces the Broken Hill Proprietary Company, Limited. Last November prices rose by 9 per cent. According to a spokesman of the company, steel would still be cheaper than on the United Kingdom and United States domestic markets and 40 per cent. cheaper than imported steel. The increases bring prices to the following levels:—Pig-iron, £A21 2s. 6d. (an increase of £A1 10s.) a ton; merchant bar steel, £A36 11s. 3d. (£A2 10s.); structural steel, £A35 11s. 9d. (£A3); steel plates, £A41 6s. 4d. (£A3 5s.).

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Company News

EFCO, LIMITED (formerly the Electric Furnace Company, Limited)—Group trading profits expanded from £218,922 to £255,584 in the year ended March 31, and reflect the best figure recorded in the history of the company.

STEEL & COMPANY, LIMITED—A final dividend on ordinary stock of 12½ per cent., making 17½ per cent. on £750,000 after the scrip issue, is recommended for the 52 weeks to March 27, 1955. Total dividend for the preceding period was 20 per cent. on £500,000 before the free issue in September, 1954. The 1954-55 payment shows an equivalent increase of 4⅛ per cent. Group net profits are doubled, at £379,024, against £180,086 in the previous year.

HILL TOP FOUNDRY COMPANY, LIMITED—The directors announce that a group of companies has expressed a desire to acquire the share capital of the company and negotiations are proceeding. Shareholders are advised to await a further announcement which will be made as soon as circumstances permit and communicated to them personally by letter. In the event of the negotiations being successfully concluded, provision will be made for continuity of management and supplies to customers.

MODERN MACHINE TOOLS, LIMITED—The directors announce an ordinary stock capital distribution of 5s., free of tax, per 5s. unit. As intimated when the Gas Purification & Chemical Company, Limited, made an offer to acquire the capital, accepted by 89½ per cent., no dividend is recommended for the 10 months to December 31 last, against 20 per cent. per annum for the previous 14 months. Holders who accepted the offer will receive the final dividend of 75 per cent. proposed by Gas Purification.

LAKE & ELLIOT, LIMITED, steelfounders, of Braintree (Essex)—Shareholders are informed that the directors have made an offer to purchase the whole of the issued 77,500 £1 ordinary and 25,451 preference £1 shares of the National Steel Foundry (1914), Limited, Leven (Fife), at £4 4s. 3d. per ordinary and £1 2s. 6d. per preference share. The offer is conditional on acceptance by the holders of at least 90 per cent. in value, or such lesser number as may be agreed, of the ordinary shares. The directors of the National Steel Foundry (1914) have all agreed to sell their holdings, aggregating 58,431 ordinary and 11,096 preference shares, and they are recommending all shareholders to accept the offer.

Rise in Industrial Output Held

Industrial output in July, when allowance is made for the different incidence of holidays, would appear to have maintained the steady 5 to 6 per cent. rate of growth of the first half of the year. According to a Treasury announcement, it is estimated that the index of industrial production for July will be 121-122 (1948 = 100) compared with 117 in July last year. This represents an increase of only 3¾ per cent.—the actual increase in the first six months of the year was 5.8 per cent.—but the figures for July covered more of the holiday period which normally spans the August Bank holiday weekend than in July, 1954.

The rise in production this year has depended to an even greater extent than in 1954 on the metal making and using industries. The most spectacular single rise has been in the vehicle industry, where an increase in production of 14 per cent. has accounted for over one fifth of the advance in industrial output.

Personal

Mr. EDWIN B. FULTON has resigned as a director of the David Brown Corporation.

Mr. G. R. WEBSTER has changed his home address from Bedford to "The Oaks," Kewferry Drive, Moor Park, Northwood, Middlesex.

Mr. T. SAMSON has been appointed chief draughtsman of the trackwork department of Edgar Allen & Company, Limited, steel and tool makers, etc., of Sheffield.

Sir SUMMERS HUNTER, who has recently retired as managing director of Richardsons, Westgarth & Company, Limited, and its subsidiaries, has joined the board of Vent-Axia, Limited.

Mr. JOHN V. SHEFFIELD has been appointed chairman of Horseley Bridge & Thomas Piggott, Limited, constructional engineers, in succession to the Earl of Dudley, who is retiring.

Mr. JACK JONES, M.P. for Rotherham, has been appointed welfare officer to the Lancashire Steel Corporation. Before becoming a member of Parliament, Mr. Jones was a melter with the Lancashire Steel Corporation.

Mr. H. G. GOYNS, past-president of the Institute of British Foundrymen (South African branch), has been elected president of the Institution of Production Engineers (South African branch), for the year 1955/56. Mr. Goyns left South Africa recently to study the latest British developments in the fields of arc- and resistance-furnace equipment.

Dr. THOMAS GIRTIN recently retired from the chairmanship of Johnson & Sons Smelting Works, Limited. He joined the board of the parent company, Johnson, Matthey & Company, Limited, in 1921 from Raphael's Refinery, where he had been general manager, and remained on that board until 1952. His appointment to the chairmanship of Johnson & Sons Smelting Works came in 1930 after he had been actively concerned in the amalgamation of the two companies. Amongst his early work for Johnson, Matthey & Company, Limited, was the re-organization and integration of the refineries at Hatton Garden. Later, he was responsible for building the research laboratories at Wembley.

Obituary

MR. JOHN GRANT, former works manager for J. W. Singer & Sons, Limited, has died at the age of 78.

THE DEATH OCCURRED, on August 29, at Wolverhampton, of Mr. WILLIAM FARQUHARSON IRELAND, who was inspector of factories for the Wolverhampton area from 1922 till his retirement in 1929. His appointment as a factory inspector dated from 1896. He was 88 years old.

THE DEATH, on September 1, of Mr. HERBERT THOMAS KERMODE, of Bradford, at the age of 80, is announced. In March he retired from the joint managing directorship of United States Metallic Packing Company, Limited, Soho Works, Allerton, Bradford, with which firm he had been for 63 years.

Mr. HAROLD HILLIER, director and chief executive engineer of G. & J. Weir, Limited, Glasgow, died recently at the age of 64. He controlled all the design work of Weir's as well as the technical development associated with it. In 1953 Mr. Hillier was awarded the James Clayton prize, valued at more than £800, for his contribution to marine engineering.

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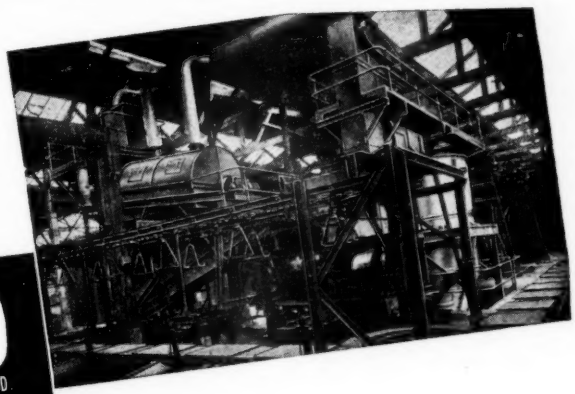

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F.T.2

Raw Material Markets

Iron and Steel

Production of pig-iron at the furnaces in blast is kept at a high level. Better iron-ore deliveries are now being received and there are reasonable supplies of blast-furnace coke, so that adequate tonnages of raw materials should be available to maintain present outputs and provide for the new furnaces which will be brought in later in the year.

Demands are at a high level. Makers of basic pig-iron are under continuous pressure from the steelworks; although the bulk of present output is in this grade of pig-iron, larger tonnages are required than are forthcoming.

So far as supplies for the foundries are concerned, the heaviest demands are for the low- and medium-phosphorus irons and hematite. The engineering and speciality foundries are busy and find it impossible to obtain adequate tonnages of the low- and medium-phosphorus grades. Hematite makers have relieved the position to some extent by the improved deliveries which they have been able to make recently, but there is still a gap between the supply and demand. Refined irons are being used where possible, and some foundries have augmented their stocks with imported iron.

Some of the light foundries have reduced their demands for high-phosphoric pig-iron, among them the makers of castings for domestic utensils. The demand has been adversely affected by hire-purchase restrictions, and stocks of castings are not being utilized to the same extent as before. Makers of builders' castings are also receiving smaller demands. The jobbing foundries are generally busy and are maintaining their demands for pig-iron.

Light scrap for the foundries appears to be plentiful, but there is still a good demand for heavy cast-iron and machinery scrap, as well as for steel scrap. Foundry coke is sufficient to satisfy current consumption requirements, but some of the Welsh grades are still scarce.

Some imports of steel semis are coming to hand, and with a slight improvement in deliveries from home steelworks the supply position is a little easier. The pressure for deliveries, however, has eased to some extent, but this is mainly because of shortage of labour at the re-rolling mills. There are plenty of orders on hand for small bars, light sections, strip, etc., but labour difficulties are an obstacle to improved outputs, and it is reported that some re-rolling mills have been forced to reduce the number of working shifts.

Non-ferrous Metals

The announcement at the weekend that with effect from Monday the Rhodesian Selection Trust was raising its selling price for copper by £35 to £360 per ton, c.i.f. United Kingdom, represented the second increase since the copper price stabilization scheme was introduced in May. The latest price is now subject to alteration at 24 hours' notice. Under the original scheme, it will be recalled, the price was fixed for a period of not less than 30 days after which time the price was subject to revision at one day's notice. Notwithstanding the possibility that the present price may remain unchanged for a considerable period, the amended system must be viewed as something of a failure for the price stabilization scheme. But against this must be considered the period of rapidly changing copper prices in London and the rest of the world.

Indeed, a high level of demand from both domestic and Continental sources has combined to hoist the price for cash copper over the £400 per ton mark for the second time in two weeks, and Tuesday's settlement price stood at a new peak of £402 while the settlement price yesterday (Thursday) gained a further 10s.

The tin market has been dull. The price is still weakening, although consumer demand is being maintained. Purchases of tin on the Continent and in the US have been reported as good.

The lead market here continues firm, with nearby supplies tending to become scarce. In the US demand is strong and consumption during the first six months of this year, at 570,942 short tons, compares with 542,190 tons in the comparable period a year ago. The zinc market here is still improving, with the price moving to higher levels. On the other side of the Atlantic the call for zinc has been exceptionally strong and these trends were reflected in an increase of ¼ cent in the US price on Tuesday, bringing the current quotation to 13 cents per lb.

Official metal prices were as follow:—

COPPER, Standard—*Cash:* September 1, £393 to £394; September 2, £392 to £393; September 5, £393 10s. to £394 10s.; September 6, £400 to £402; September 7, £402 to £402 10s.

Three Months: September 1, £387 to £387 10s.; September 2, £386 10s. to £387 10s.; September 5, £389 to £389 10s.; September 6, £394 to £395; September 7, £395 to £395 10s.

TIN, Standard—*Cash:* September 1, £747 10s. to £748; September 2, £746 10s. to £747 10s.; September 5, £744 10s. to £745; September 6, £742 to £743; September 7, £745 10s. to £746.

Three Months: September 1, £747 to £748; September 2, £746 10s. to £747 10s.; September 5, £744 to £744 10s.; September 6, £743 to £744; September 7, £745 10s. to £746.

LEAD—*First half September:* September 1, £107 to £107 10s.; September 2, £107 to £107 10s.; September 5, £107 to £107 5s.; September 6, £107 10s. to £107 15s.; September 7, £107 15s. to £108.

First half December: September 1, £106 15s. to £107; September 2, £106 15s. to £107; September 5, £106 15s. to £107 5s.; September 6, £107 to £107 5s.; September 7, £107 10s. to £107 15s.

ZINC—*First half September:* September 1, £90 5s. to £90 10s.; September 2, £90 10s. to £90 12s. 6d.; September 5, £90 10s. to £91; September 6, £91 to £91 10s.; September 7, £92 10s. to £93.

First half December: September 1, £89 15s. to £90; September 2, £90 to £90 5s.; September 5, £90 to £90 5s.; September 6, £90 10s. to £90 15s.; September 7, £91 15s. to £92.

Another Reminder

There are still vacancies on all the trips planned for the National Works Visits Day of the Institute of British Foundrymen in the Bristol area on October 7. It is, therefore, still possible for members to select visits of their choice from the following: (*1*) Westinghouse Brake & Signal Company, Limited, and Stothert & Pitt, Limited; (*2*) Newman, Hender & Company, Limited, and T. H. & J. Daniels, Limited; (*3*) Newman, Hender & Company, Limited, and R. A. Lister & Company, Limited; (*4*) National Smelting Company, Limited, and Charles Hill & Sons, Limited; and (*5*) Bristol Aeroplane Company, Limited, and Douglas (Kingswood), Limited. Applications for places should be made immediately to the secretary of the Institute, Mr. G. Lambert, St. John Street Chambers, Deansgate, Manchester, 3.

FOUNDRY FUMES???

Though corebinder developments have not yet reached the stage where it is possible to guarantee a complete absence of unpleasant casting odours, B.I.P.'s latest synthetic resin corebinder—Beetle W42—represents a very considerable advance in this direction. Developed with the Garrett Report in mind, it combines all the advantages of Beetle W20 with a reduction in casting odour that will be appreciated by foundrymen.

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Write for technical information to B.I.P. Chemicals Limited,
Tat Bank House, Oldbury, Nr. Birmingham. London Office : 1 Argyll Street, W.1.
'Beetle' is a trade mark registered in Great Britain and in most countries of the World.

**Patent Application 32896/58*

Current Prices of Iron, Steel, and Non-ferrous Metals

(Delivered unless otherwise stated)

September 7, 1955

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £17 1s. 0d.; Birmingham, £16 13s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £18 12s. 9d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si), d/d within 60 miles of Stafford, £19 8s. 3d.

Scotch Iron.—No. 3 foundry, £19 5s. 6d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £21 3s. 0d.; South Zone, £21 5s. 0d.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £22 0s. 0d.; South Zone, £22 3s. 0d.

Hematite.—Si up to 2 per cent., S. & P. over 0.03 to 0.05 per cent.:—N.-E. of England (local iron), £19 5s.; Scotland (Scotch iron), £19 11s. 6d.; Sheffield, £20 12s. 0d.; Birmingham, £20 19s. 6d.; Wales (Welsh iron), £19 11s. 6d.

Basic Pig-iron.—£16 16s. 6d. all districts.

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered)

Ferro-silicon (6-ton lots and over).—45 per cent. Si, £40 15s. 0d., scale 15s. per unit; 75 per cent. Si, £63 0s. 0d., scale 16s. per unit.

Ferro-vanadium.—50/60 per cent., 23s. 8d. to 25s. 0d. per lb. of V.

Ferro-molybdenum.—65/75 per cent., carbon-free, 11s. 0d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £230 0s. 0d.; 38/40 per cent., £279 0s. 0d.

Ferro-tungsten.—80/85 per cent., 17s. 10d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 20s. 10d. per lb. of W.

Ferro-chrome (6-10 ton lots).—4/6 per cent. C, £83 0s. 0d. to £86 0s. 0d., basis 60 per cent. Cr, scale 25s. 0d. per unit; over 6 per cent. C, £81 0s. 0d. to £84 0s. 0d., basis 60 per cent. Cr, scale 24s. 0d. per unit; 2 per cent. C,* 1s. 11½d. per lb. Cr; 1 per cent. C,* 2s. 0d. per lb. Cr; 0.15 per cent. C,* 1s. 11d. to 2s. 1d. per lb. Cr; 0.10 per cent. C,* 1s. 11d. to 2s. 2d. per lb. Cr; 0.06 per cent. C,* 2s. 3d. per lb. Cr.

Metallic Chromium.—98/99 per cent., 7s. 0d. to 7s. 6d. per lb.

Metallic Manganese.—93/95 per cent., carbon-free, £249 0s. 0d.; 96/98 per cent., £269 0s. 0d.

Ferro-columbium.—60/75 per cent., Nb + Ta, 37s. per lb., Nb + Ta.

Ferro-manganese (home).—78 per cent., £53 17s. 6d.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft, u.t., £26 19s. 0d.; tested, 0.08 to 0.25 per cent. C, £27 19s. 0d.; hard (0.41 to 0.60 per cent. C), £29 5s. 6d.; silico-manganese, £36 7s. 6d.; free-cutting, £31 0s. 6d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £34 12s. 0d.; silico-manganese, £36 7s. 6d.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £31 11s. 0d.; basic, hard, over 0.41 up to 0.60 per cent., C, £32 13s. 6d.; acid, up to 0.25 per cent. C, £35 12s. 6d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £33 1s. 6d.; boiler plates (N.-E. Coast), £35 11s. 6d.; floor plates (N.-E. Coast), £34 10s. 6d.; sectional material, N.-E. Coast, £30 19s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested, £33 19s. 6d.; flats, 5 in. wide and under, £33 19s. 6d.; hoop and strip, £35 1s. 6d.; uncoated strip mill coils, hot rolled, under 3mm. to 12g., £36 5s. 0d.; black sheets (hand mill), 17/20 g., £46 13s. 6d.; galvanized corrugated sheets, 24 g., £58 11s. 0d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £58 0s. 3d.; nickel-chrome, £81 10s. 0d.; nickel-chrome-molybdenum, £92 7s. 6d.

NON-FERROUS METALS

Copper.—Cash, £402 0s. 0d. to £402 10s. 0d.; three months, £395 0s. 0d. to £395 10s. 0d.; settlement, £402 10s. 0d.

Copper Tubes, etc.—Solid-drawn tubes, 3s. 6¾d. per lb.; rods, 418s. 3d. per cwt. basis; 20 s.w.g., 451s. 6d. per cwt.

Tin.—Cash, £745 10s. 0d. to £746 0s. 0d.; three months, £745 10s. 0d. to £746 0s. 0d.; settlement, £746 0s. 0d.

Lead (Refined Pig).—First half September, £107 15s. 0d. to £108 0s. 0d.; first half December, £107 10s. 0d. to £107 15s. 0d.

Zinc.—First half September, £92 10s. 0d. to £93 0s. 0d.; first half December, £91 15s. 0d. to £92 0s. 0d.

Zinc Sheets, etc.—Sheets, 15 g. and thicker, all English destinations, £122 5s. 0d.; rolled zinc (boiler plates), all English destinations, £120 0s. 0d.; zinc oxide (Red Seal), d/d buyers' premises, £103 0s. 0d.

Brass Tubes, etc.—Solid-drawn tubes, 2s. 9¾d. per lb.; rods, drawn, 3s. 7¼d.; sheets to 10 w.g., 346s. 3d. per cwt.; wire, 3s. 4¾d.; rolled metal, 346s. 3d. per cwt.

Brass (Brazing).—BS1400, B3 (65/35), £236; B6 (85/15), — BS249, —

Brass (High Tensile).—BS1400, HTB1 (30 tons), £298; HTB2 (38 tons), — HTB3 (48 tons), £325.

Gunmetal.—RCH, 3/4 per cent. tin, —; BS1400, LG2 (85/5/5/5), £332; LG3 (86/7/5/2), £344; G1 (88/10/2/½), £408; (88/10/2/1), £402.

Phosphor Bronze.—BS1400, PB1 (AID released), £428 per ton.

Phosphor Bronze Strip, etc.—Strip, 507s. 0d. per cwt.; sheets to 10 w.g., 530s. 6d. per cwt.; wire, 5s. 1½d. per lb.; rods, 4s. 5¾d.; tubes, 4s. 4d.; chill cast bars: solids 4s. 6d. cored 4s. 7d. (CHARLES CLIFFORD, LIMITED.)

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × 0.056, 4s. 5½d. per lb.; round wire, 10g. in coils (10 per cent.), 4s. 10d.; special quality turning rod, 10 per cent.; ½ in. dia., in straight lengths, 4s. 9d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 4d. per lb. Antimony, English, 99 per cent., £210 0s. 0d. Quicksilver, ex-warehouse, £92 0s. 0d. to £95 0s. 0d. Nickel, £519 0s. 0d. Aluminium, ingots, £171 0s. 0d.; aluminium bronze (BS1400), AB1, £370; AB2, £380. Solder, brazing, BS1845, 3s. 0½d. lb.; granulated, 3s. 4½d. lb.

* Average 68-70 per cent.

New Patents

(Copies of complete specifications are obtainable from the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, London, W.C.2, price 2/-.)

735,355. G. B. E. Schueler, The Old College, Tideswell, near Buxton, Derbys.

A process of producing hollow sand cores. It comprises the sudden blowing of an intimate mixture of sand and a thermo-setting resin into a closed and heated mould.

735,483. Imperial Chemical Industries, Limited, Imperial Chemical House, Millbank, London, S.W.1.

A method for the manufacture of titanium- or zirconium-base alloys, containing metallic alloying ingredients, by an arc-melting process which comprises the incorporation of these ingredients in the form of one or more master alloys or compacted powder mixtures. These mixtures will have a specific gravity of about that of the basis metal.

735,564. Polygram Casting Company, Limited, Power Road, Gunnersbury, London, W.4.

A synthetic-resin binder for mixing with sand to form a moulding mixture for use in making moulds or cores. It comprises 79 to 91 per cent. (by weight) of hardenable phenol-formaldehyde resin and/or a hardenable cresol-formaldehyde resin. The remaining 21 to 9 per cent. consists of plumbago, terra-flake, or a mixture of both plumbago and terra-flake. The ingredients should be in a dry, powdered state.

735,598. Regie Nationale des Usines Renault, 8 to 10 Avenue Emile Zola, Billancourt (Seine), France, and Société des Hauts Fourneaux et Forges D'Allevard, 12 rue de la Rochefoucald, Paris Seine), France.

A pressure-die-casting machine, particularly applicable to non-ferrous metals. It comprises an injection cylinder supplied with molten metal either directly or by means of a molten metal magazine holder. Whichever of the two cylinders first receives the molten metal is divided into two semi-cylindrical parts, the joint plane of which is horizontal. The lower of the two parts has a refractory lining opposite the pouring gate, protected by metal bars. This lining forms the joint edges of the two parts.

735,642. J. B. Brennan, 13018 Lake Shore Boulevard Cleveland, 8. Ohio, USA.

Apparatus for feeding articles or moulds by passing them through a treating or casting zone. The entire process is performed under vacuum, one of the distinctive features being that the degassing or reacting chamber and its crucible may be used in conjunction with other chambers and crucibles to feed preheated metals into the first crucible. The equipment is also a degassing apparatus or a reacting apparatus for treating metals prior to casting.

DROUGHT caused the British Aluminium Company, Limited, to close down several furnaces at its Lochaber (Inverness-shire) factory after the level of Loch Treig, which is the main water supply for the turbines, dropped 100 ft.

A FACTORY to manufacture pipe for the oil and gas industries is planned at Regina, Saskatchewan, Canada, by Hoesch (Canada), a subsidiary of the German steel concern, Hoesch Werke Aktiengesellschaft, Dortmund. The plant is expected to be in operation by next spring.

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SITUATIONS WANTED

FOUNDRY MANAGER (43). Keen modern organiser, experienced in loose pattern, strickle and mechanised production of grey iron and steel castings, desires responsible post with progressive company. Box FM478, FOUNDRY TRADE JOURNAL.

CHEMIST, 31, requires change. Ten years' experience scrap trade, five years chief chemist; experienced all non-ferrous alloys. Salary £800/£1,000. Box CR480, FOUNDRY TRADE JOURNAL.

FOUNDRY DIRECTOR, dissolution. Free in November, desires position as representative, or similar. Willing to move. Age 40. Own car available. Box FD483, FOUNDRY TRADE JOURNAL.

CHEMIST/METALLURGIST (41) seeks position with wider prospects. Comprehensive experience carbon, alloy steel, and malleable iron production techniques. Accustomed to responsibility and administration.—Box CM494, FOUNDRY TRADE JOURNAL.

TECHNICAL SUPERINTENDENT, age 26, 7 years' experience, now seeks position in S. England. Responsible for producing aluminium, magnesium and bronze castings by Shell and several precision processes. General metallurgical knowledge, specialised in H.T.B.—Box TS490, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 *inclusive or a woman aged* 18-59 *inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order,* 1952.

BRASS Gravity Die Casting TECHNICIAN required for a growing Foundry specialising in the production of Plumbers' Brass-ware. Applicant must have a complete knowledge of this branch of the foundry trade and be capable of organising and maintaining a high rate of production. This is a position for a very energetic and determined personality. Age not exceeding 40. Salary in accordance with experience. Contributory pension scheme. Southern area.—Box BG326, FOUNDRY TRADE JOURNAL.

FOUNDRY CHEMIST and METALLURGIST required for Malleable and Grey Iron Foundry. Excellent opportunity for young man. Salary in the neighbourhood of £500 depending on experience. Apply in writing to RESIDENT DIRECTOR, Shanks Ironfounders Ltd., Dens Iron Works, Arbroath.

PATTERNMAKERS used to first class Wood and Metal work required by Coventry firm of Master Patternmakers. Top wages and excellent conditions. Box PU442, FOUNDRY TRADE JOURNAL.

IRON MOULDERS and COREMAKER, also experienced FURNACEMEN and FETTLER required for Jobbing Foundry, Nottingham district. State experience and wages required. Box I.M.460, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT—*contd*

DRAUGHTSMEN. — Applications are invited from Senior and Junior Draughtsmen to fill positions which have resulted from our expanding commitments. The work would involve the design and detailing of welded fabrications, pipework and light steel structures in connection with major installations. Excellent prospects of subsequent promotion exist for persons having initiative and an ability to accept responsibility.—Candidates should apply in writing to W. C. HOLMES & CO., LTD., Huddersfield, giving full details of previous experience, etc.

REQUIRED.—ASSISTANT to Plant Engineer. Experience in foundry maintenance an advantage. Apply with full details of age, experience, qualifications and salary required, to BRITANNIA IRON & STEEL WORKS LTD., Bedford.

FOUNDRY MANAGER required by Midland Ironfoundry producing at present approx. 100 tons weekly, with scope for considerable increase in production. Suitable applicants must be capable of taking full charge, and be keen, energetic and efficient. The ability to show initiative and to act upon it, to maintain production programmes and to control staff and labour being essential. Opportunity to join Board afforded to engaged applicant after agreed trial period. Apply stating experience, age and salary required to BOX FM466, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT—*contd*

STEEL FOUNDRY SALES REPRESENTATIVE required by small steel foundry in Sheffield, capable of estimating weights from drawings, pricing the castings and subsequently visiting customers. The position would be partly inside and partly outside work, with a view to ultimately taking full responsibility as Sales Manager. Previous steel foundry experience is essential and applicants should be preferably between the age of 30 and 35 years. Replies giving details of experience, salary expected, etc., will be treated in the strictest confidence, to Box SF433, FOUNDRY TRADE JOURNAL.

R. & A. MAIN, LTD., invite applications for the position of ASSISTANT GENERAL MANAGER at their Edmonton Works. Applicants should have an engineering background with a University Degree or Corporate Membership of one of the recognised Institutions. Age between 30 and 45. Administration ability is important. Excellent future prospects are offered with an attractive salary and contributory pension scheme. Please address applications in confidence to the GENERAL MANAGER, R. & A. Main, Ltd., Angel Road, Edmonton, London, N.18.

FOREMAN required for Iron Foundry in South Coast area producing Machine Tool and General Engineering castings. Energetic man with sound knowledge of Foundry practice and ability to supervise and train labour. Box FR467, FOUNDRY TRADE JOURNAL.

J. STONE & CO. (CHARLTON) LTD.

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Invite applications for the following:

STAFF APPTS.

GRAVITY DIE CASTING DEPT.

- **(a) ASSISTANT TO MANAGER**
- **(b) ASSISTANT CHIEF DESIGNER/DRAUGHTSMAN**
- **(c) WEIGHT ESTIMATOR**
- **(d) TWO DRAUGHTSMEN**

Applicants for post (a) must be capable of controlling whole department when required and for posts (a) and (b), a full knowledge of up-to-date Gravity Die Design required, and experience of practical Gravity Die Foundry Work is desirable.

These appointments offer excellent opportunities. Canteen and Sports Club facilities. Contributory Pension Scheme.

Please apply by letter or telephone to the Labour Manager. Telephone GREenwich 3277. Quoting this newspaper.